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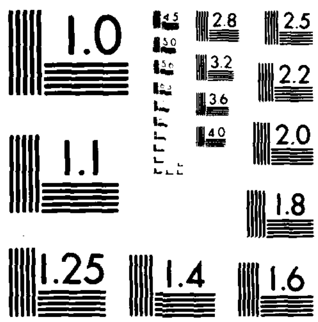

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OCEANOGRAPHIC SURVEYS IN THE TASMAN SEA USING AIRBORNE EXPENDABLE BATHYTHERMOGRAPHS

BY

M. W. LAWRENCE

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DEPARTMENT OF DEFENCE

RAN RESEARCH LABORATORY

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M. W. LAWRENCE

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~~The~~ environmental data obtained on four ocean surveys are presented. The surveys were conducted from Orion aircraft using airborne expendable bathythermographs (AXBT). The survey ~~area is~~ the Tasman Sea, ~~the survey dates~~ between August 1978 and May 1979.

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1. INTRODUCTION

Synoptic ocean analysis and forecasting are useful in Naval operations, particularly in anti-submarine warfare. Detection of submerged submarines is usually performed using underwater sound. The propagation of underwater sound is significantly affected by the oceanographic conditions (particularly temperature structure) along the propagation path.

An important tool in providing data for synoptic ocean analysis is a satellite equipped with an infra-red scanning system, which provides images of the sea surface in terms of sea surface temperature. These satellite infra-red images are potentially very useful as they provide frequently updated synoptic information over a large ocean area. There is a need to verify the accuracy of the sea surface temperature data and to determine the relationship between the measured data and the underlying thermal structure.

Oceanographic surveys are required in order to determine this "ground truth" data together with the underlying thermal structure. In traditional investigations of physical oceanography, such surveys have been performed using hydrographic casts with Nansen bottles and reversing thermometers (or in more recent times, using Conductivity - Temperature - Depth sensors). These techniques required halting the ship in order to make the measurements. Underway methods of measurement were developed which avoided the time lost in making a cast. First the mechanical bathythermograph was developed, followed by the expendable bathythermograph (XBT) and subsequently the expendable conductivity - temperature - depth probe.

These underway bathythermographs are deployed from a ship, thus limiting the path length that can be surveyed in one day to approximately 500 km (for 12 knot ship speed). The survey will only be synoptic provided that it takes less time than the typical time scale for changes in the oceanic thermal structure.

A typical space scale in the ocean is 300 km, which is the horizontal dimension of a mesoscale eddy. (Much finer scale space structure is sometimes shown in satellite infra-red photographs). The typical feature may move through its own diameter in a period of approximately 30 days.

In order to ensure a synoptic survey, it is necessary to complete the survey in a time which is a small fraction of 30 days. Approximately 7 days is an upper limit for a synoptic survey in some ocean areas. A ship can not carry out an oceanic survey over an area much larger than a mesoscale eddy without encountering problems due to lack of synopticity.

The RAN Research Laboratory is currently investigating the Heat Capacity Mapping Mission (HCMM) satellite infra-red images of the ocean surface in the Tasman Sea. This investigation includes the gathering of ground truth data both on sea surface temperature and on the sub-surface temperature structure. The infra-red images are of course synoptic images. Thus, synoptic surveys for the ground-truth data are especially desirable, in order to make a valid comparison.

Synoptic surveys can be made using the airborne expendable bathythermographs (AXBT). The AXBT is launched from an aircraft and sends the information on the temperature structure back to the aircraft via a radio link. The track length per day of an aircraft is, of course, much longer than that of a ship. Synoptic surveys can thus be made over a large area, limited only by aircraft endurance and grid spacing.

Four separate AXBT surveys have been undertaken as part of the HCMM investigation. This report presents the data obtained on the four AXBT surveys. These data have been used extensively by Andrews, Lawrence and Nilsson (ref 1) in a discussion of the mesoscale structure of the Tasman Sea as observed by the AXBT surveys, by ship surveys from the same period, and by satellite infra-red images.

2. THE AXBT FLIGHTS

The AXBT flights took place on 29-30 August 1978, 13 December 1978, 08 February 1979 and 01 May 1979. The aircraft were RAAF Orion P3B, from Edinburgh Air Force Base. The first survey took place on two days, due to an aircraft problem, with 9 of the 45 AXBTs being dropped on the second day (the southern most 9).

A very low success rate was encountered for one batch of AXBTs. This caused some problems on the second flight and severe problems on the fourth flight. The number of fully successful AXBTs on each flight was 45, 37, 47, and 16 respectively.

The AXBT used is the AN/SSQ-36, which weighs 8.2kg and conforms to the A-size sonobuoy specifications of 92cm length by 12.5cm diameter. The Orion P3B is equipped to both launch the AXBT and to receive the signal from the AXBT. The AN/SSQ-36 is available in three standard sonobuoy channel allocations: channels 12, 14, and 16.

After ejection from the aircraft the AXBT is slowed by a spin-stabilizing rotochute or a parachute. On landing in the water, an antenna deploys and salt water batteries are activated. About 5 seconds later an unmodulated radio-frequency carrier signal starts transmission. After 30 seconds the probe is released and a modulation of approximately 2000 Hz is applied to the carrier. The frequency of this modulation corresponds to the temperature of the water.

Characteristics of the AXBT are (ref 3):

a. The probe descends at 1.52m/s $\pm$ 5%.

b. Minimum depth of final operation is 305m.

c. The modulation frequency obeys the law $f = 1440 + 36T$, where f is in Hz and T is in ^{o}C.

d. Temperature accuracy $\pm$ 0.56^{o}C, over the range -2^{o}C to 35^{o}C.

After approximately 6 minutes, the AXBT transmitter is switched off, and shortly thereafter scuttled. Further discussion of the accuracy of the AXBT is given in ref 3.

On board the aircraft the modulated carrier is received and the demodulated audio frequency is converted to a d.c. voltage which is plotted on a Rustrak strip chart recorder (Model RO-308) versus time. In parallel with this aircraft inbuilt system, the signal was also recorded on a Goetz chart recorder driven by a Burr Brown 4704 frequency-to-voltage converter. This latter piece of apparatus was used to gain greater resolution on the display chart ($2^{o}C\ cm^{-1}$), than was obtained with the inbuilt recorder. The results presented here are those obtained with the Goetz recorder. A back-up tape recording was also made of the demodulated audio signal.

The track length over the ocean is approximately 4800km, for the first three flights; the fourth flight was cut short due to problems with the AXBTs. The sampling interval between AXBT drops was chosen to be approximately 100km (which is mid-way between one degree of latitude and one degree of longitude in this region).

3. RESULTS

3.1 Dynamic Topography

The dynamic topography was calculated using the method described by Nilsson and Cresswell (ref 2). Briefly, the dynamic height anomaly (0 re 1300m) was calculated for each bathythermal profile by first calculating the anomaly over the sampled depth interval from the temperature profile and temperature-salinity curves. Secondly a correction for the remaining depth interval to 1300m was obtained from regression relations between deep temperatures and dynamic height anomaly.

The AXBT profiles, in almost all cases, went to greater than 350m depth. The profile to 350m was used in the calculations of dynamic height anomaly.

Figures 1 to 4 show contours of dynamic topography (0 re 1300m) for the four surveys, together with the location of the AXBT drops.

3.2 Surface Temperature

Figures 5 to 8 show surface temperature isotherms for the four surveys.

3.3 Mixed Layer Depth

In these results, the surface mixed layer depth is that depth at which the temperature has fallen $0.2^{o}C$ below that of the mixed layer at the surface (ignoring afternoon effect type perturbations). Figures 9 to 12 show isopleths of mixed layer depth.

3.4 Temperature Sections

In each survey there was at least two long straight line paths flown. The vertical temperature sections along each of these paths is shown in Figures 13 to 30.

4. CONCLUSIONS

By using AXBTs it is possible to carry out synoptic ocean surveys over large areas. This ability to sample the ocean rapidly in three dimensions is not provided by any other technique.

The sampling interval (approximately 100km) chosen for these surveys proved adequate to resolve the mesoscale ocean structure, but could not be increased significantly without introducing resolution problems.

ACKNOWLEDGEMENTS

I wish to acknowledge the assistance on the flights of the RAAF Orion crews and of Mrs S.M. Ball of DRCS. The dynamic height anomalies were calculated using a computer program devised by Dr C.S. Nilsson. Most of the AXBTs were provided by Mr R.E. Stevenson of the Office of Naval Research in the U.S.A., through liaison with Mr P.D. Scully-Power of NUSC and Dr J.C. Andrews of DRCS, in support of NASA Project HCM-051. The remainder of the AXBTs were provided by the RAAF.

REFERENCES

1. Andrews, J.C., M.W. Lawrence and C.S. Nilsson (1980). Observations of the Tasman Front. J. Phys. Oceanogr., scheduled for November 1980 issue.

2. Nilsson, C.S. and G.R. Cresswell (1980). The formation and evolution of East-Australian-Current eddies. In Progress in Oceanography, Pergamon Press, Oxford, in press.

3. Sessions, M.H., T.P. Barnett, and W.S. Wilson (1976). The airborne expendable bathythermograph. Deep-Sea Res., 23, 779.

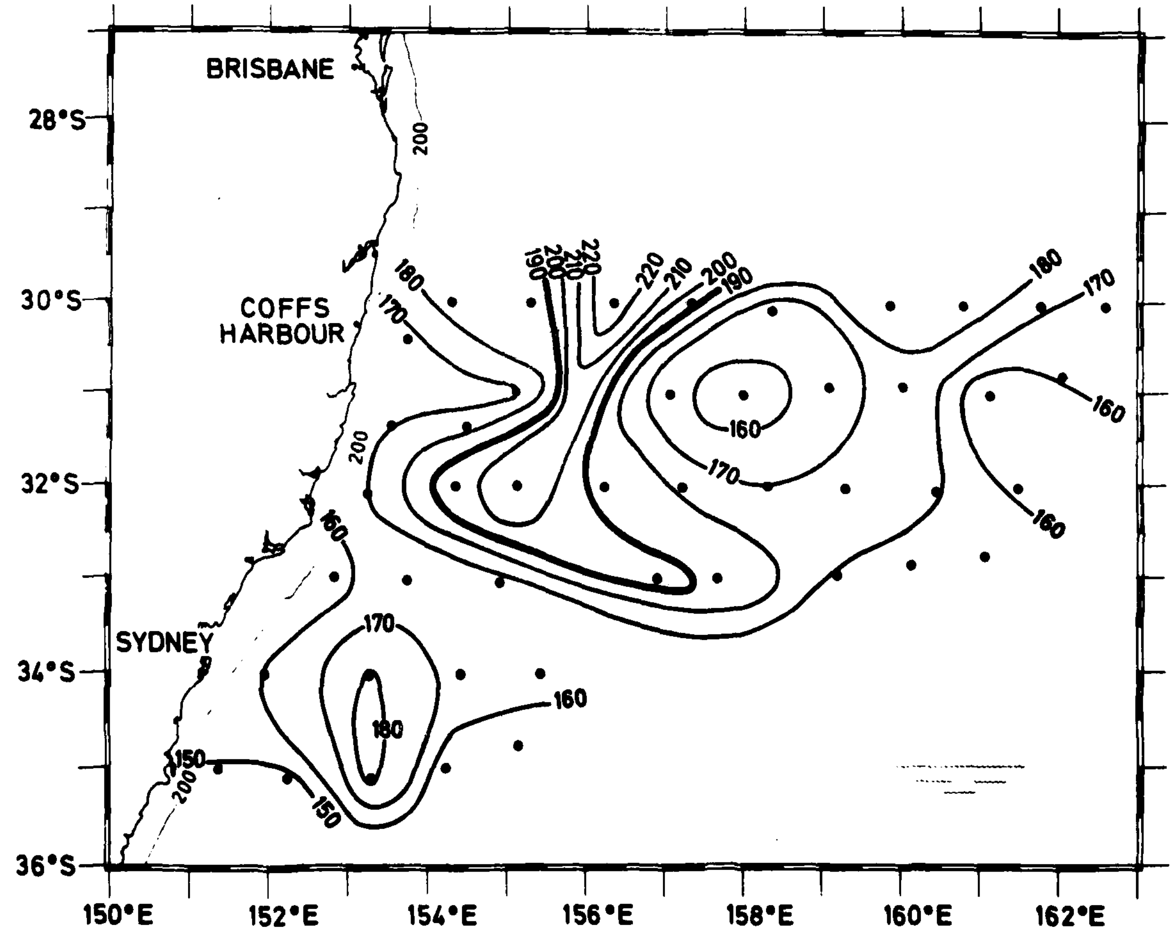

Figure 1   Dynamic Height Anomaly (0 re 1300 m) 29-30 August 1978. Contours are in dynamic centimetres. Dots are AXBT drop locations.

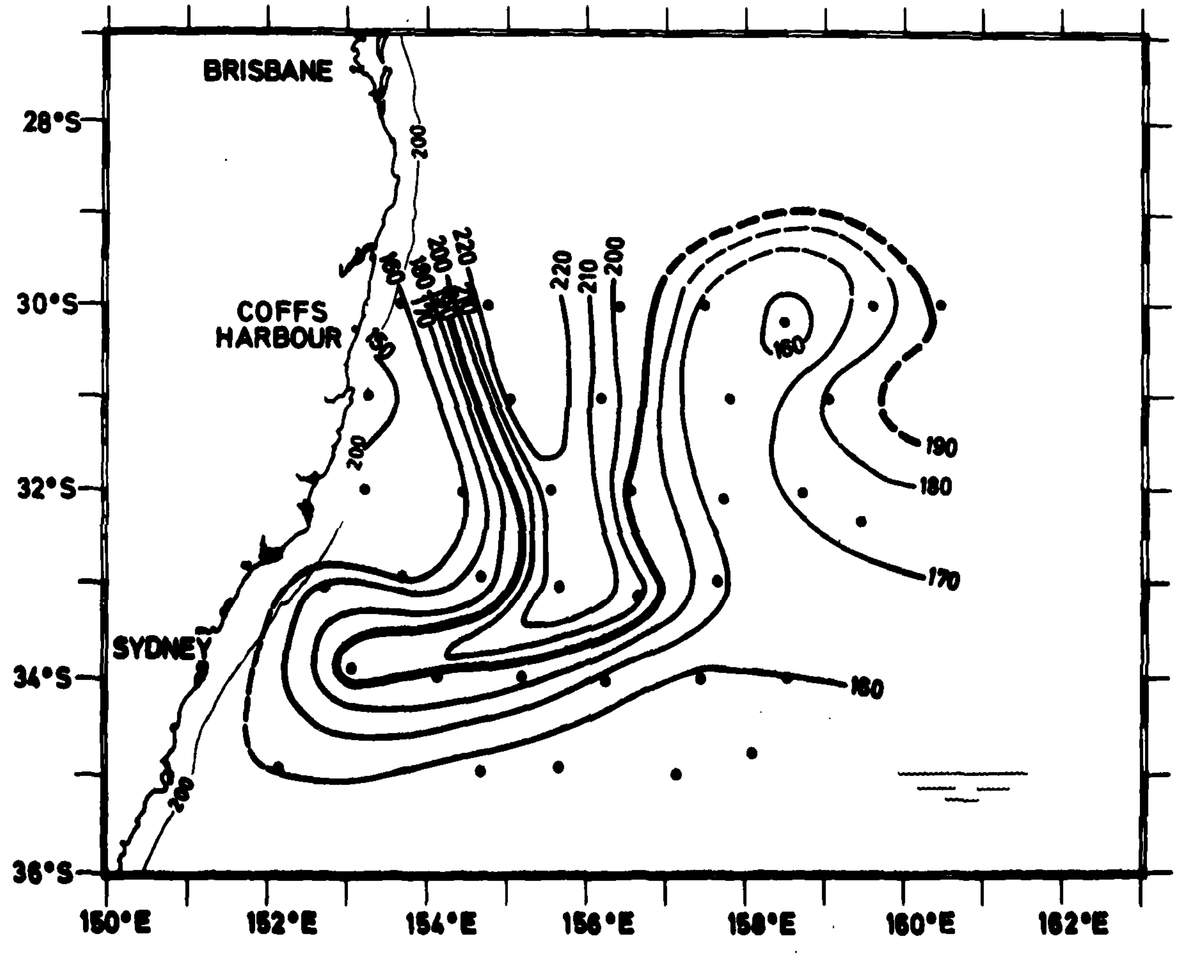

Figure 2 Dynamic Height Anomaly (0 re 1300 m) 13 December 1978. Contours are in dynamic centimetres. Dots are AXBT drop locations.

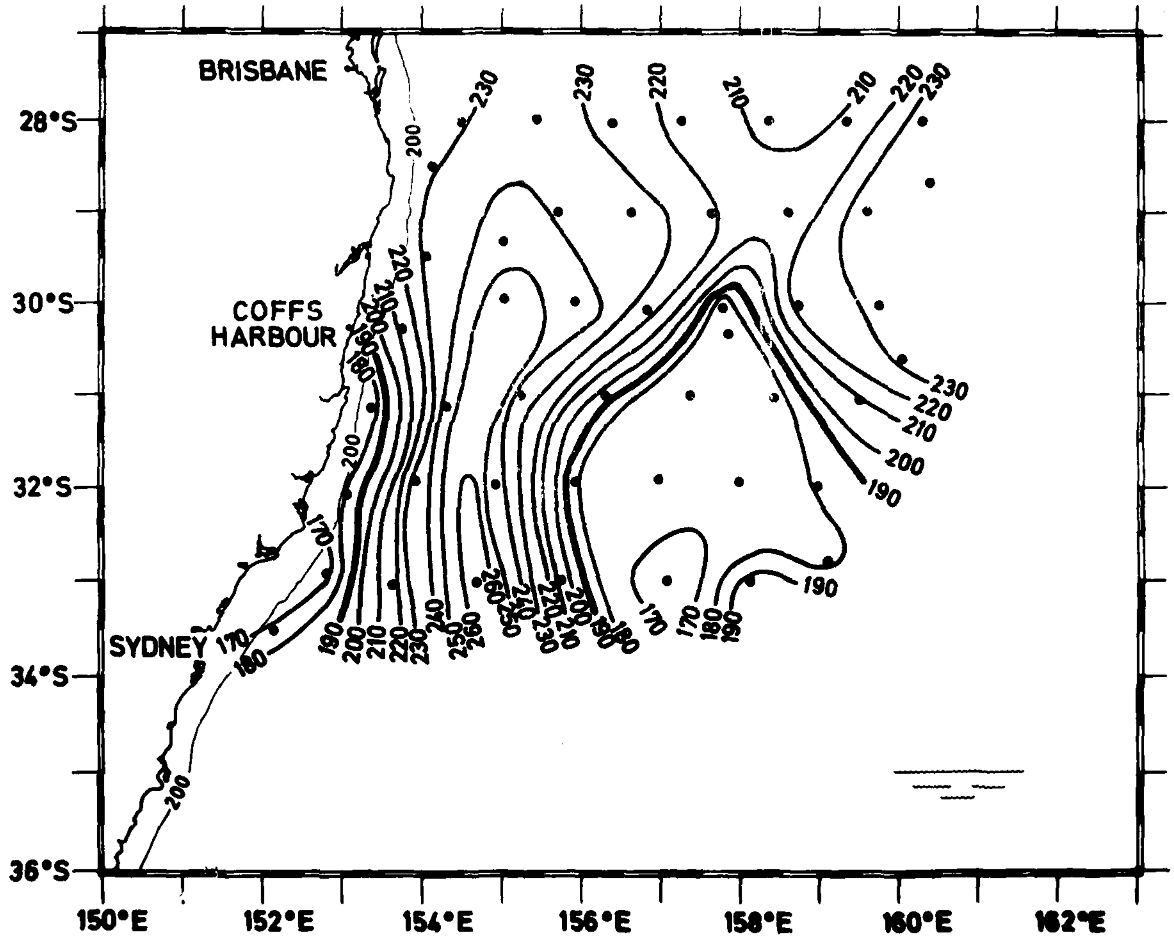

Figure 3 Dynamic Height Anomaly (0 re 1300 m) 08 February 1979. Contours are in dynamic centimetres. Dots are AXBT drop locations.

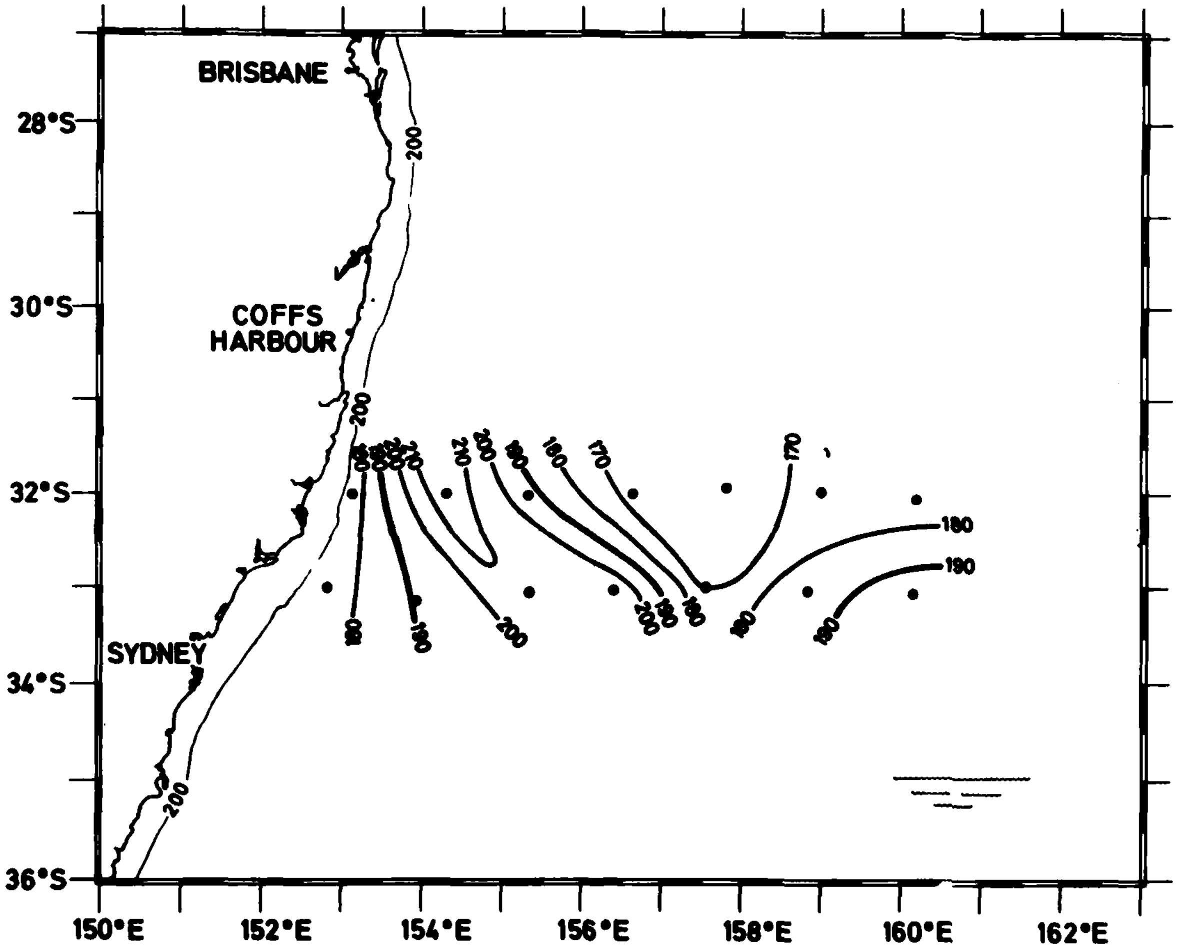

Figure 4 Dynamic Height Anomaly (0 re 1300 m) 01 May 1979. Contours are in dynamic centimetres. Dots are AXBT drop locations.

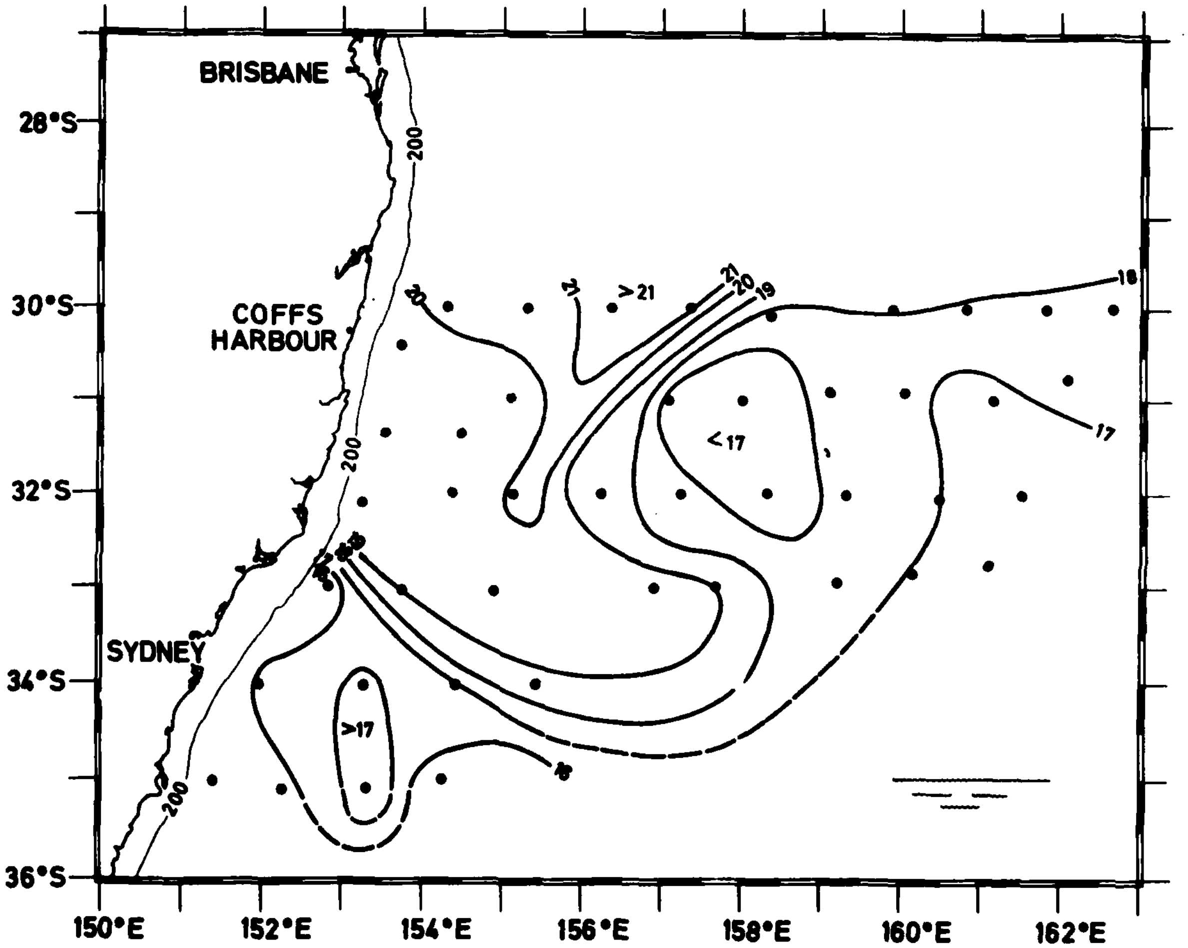

Figure 5 Surface Temperature (in degrees Celsius) 29-30 August 1978.

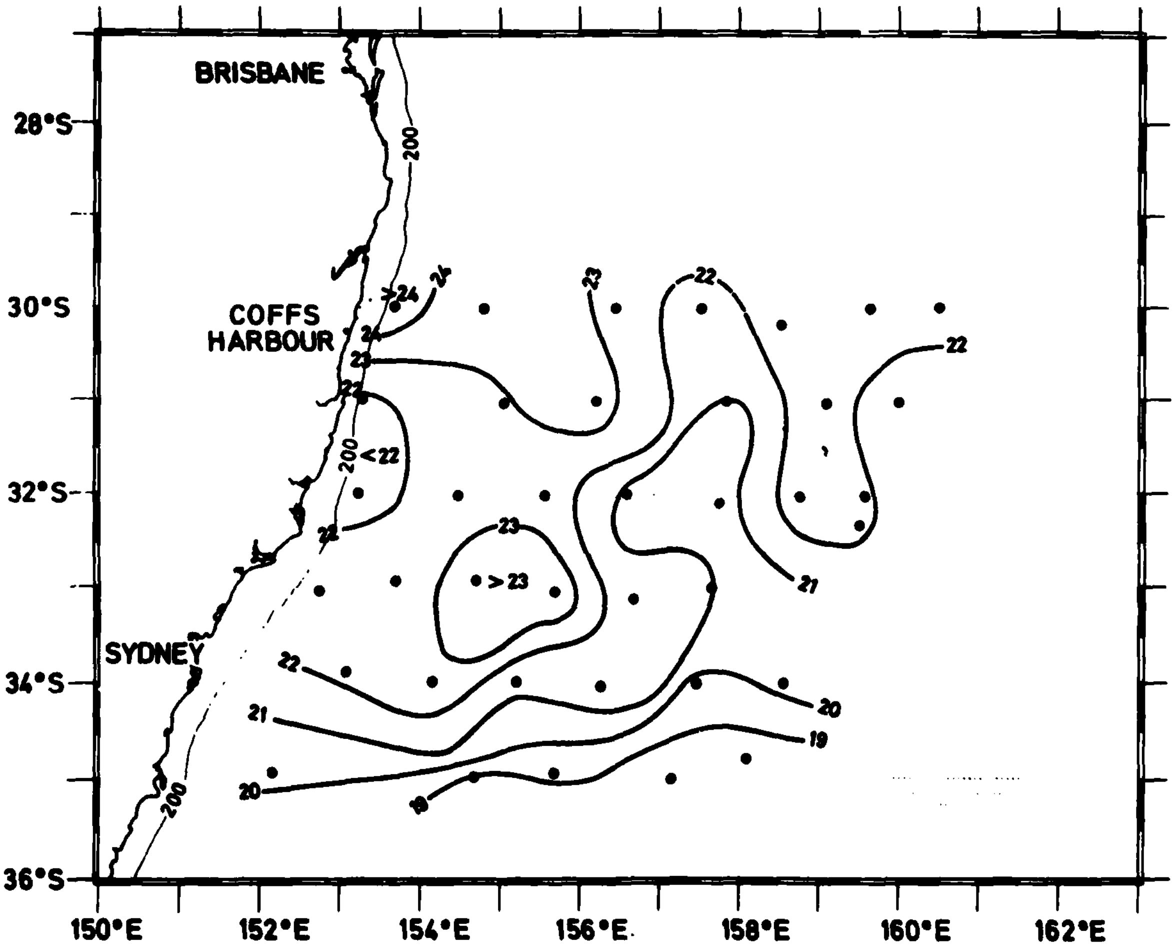

Figure 6 Surface Temperature (in degrees Celsius) 13 December 1978.

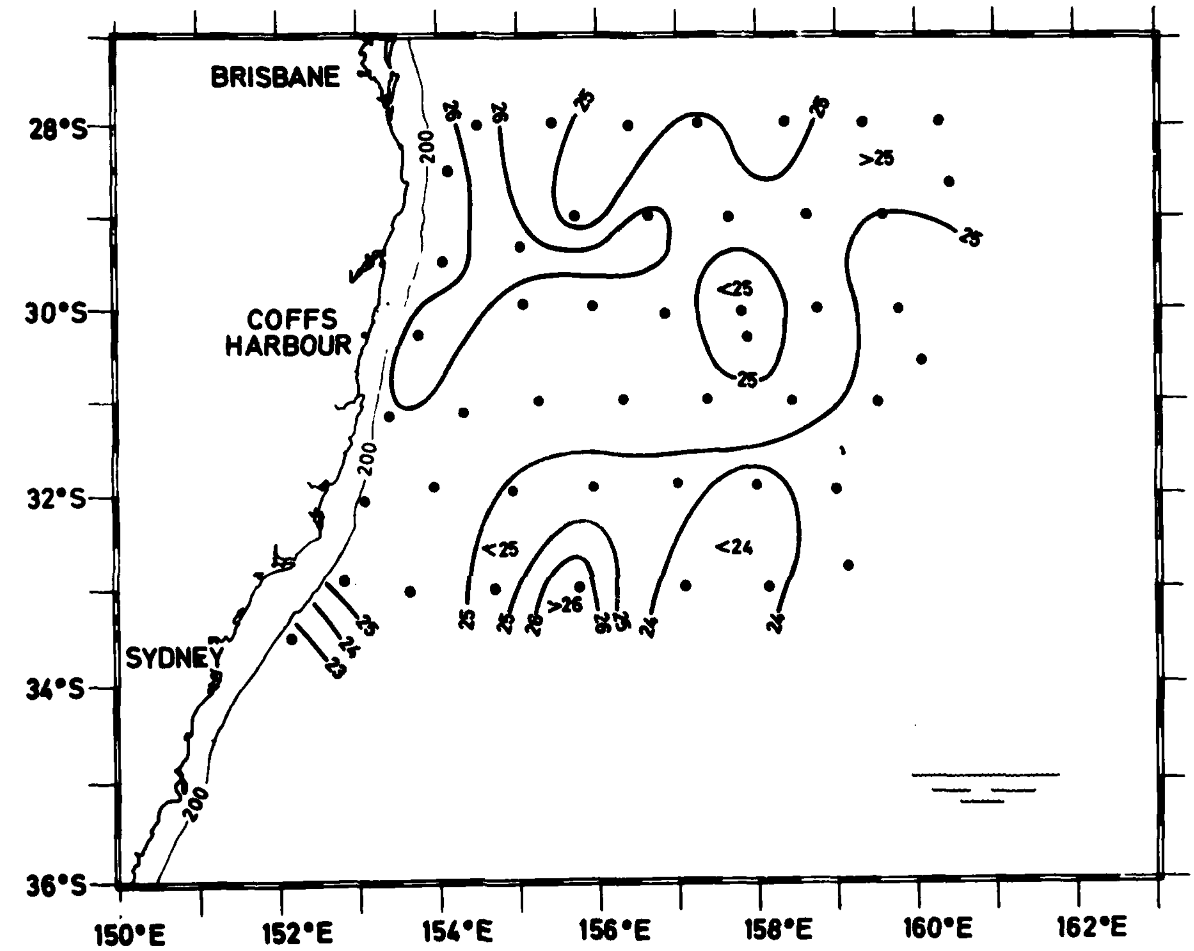

Figure 7 Surface Temperature (in degrees Celsius) 08 February 1979.

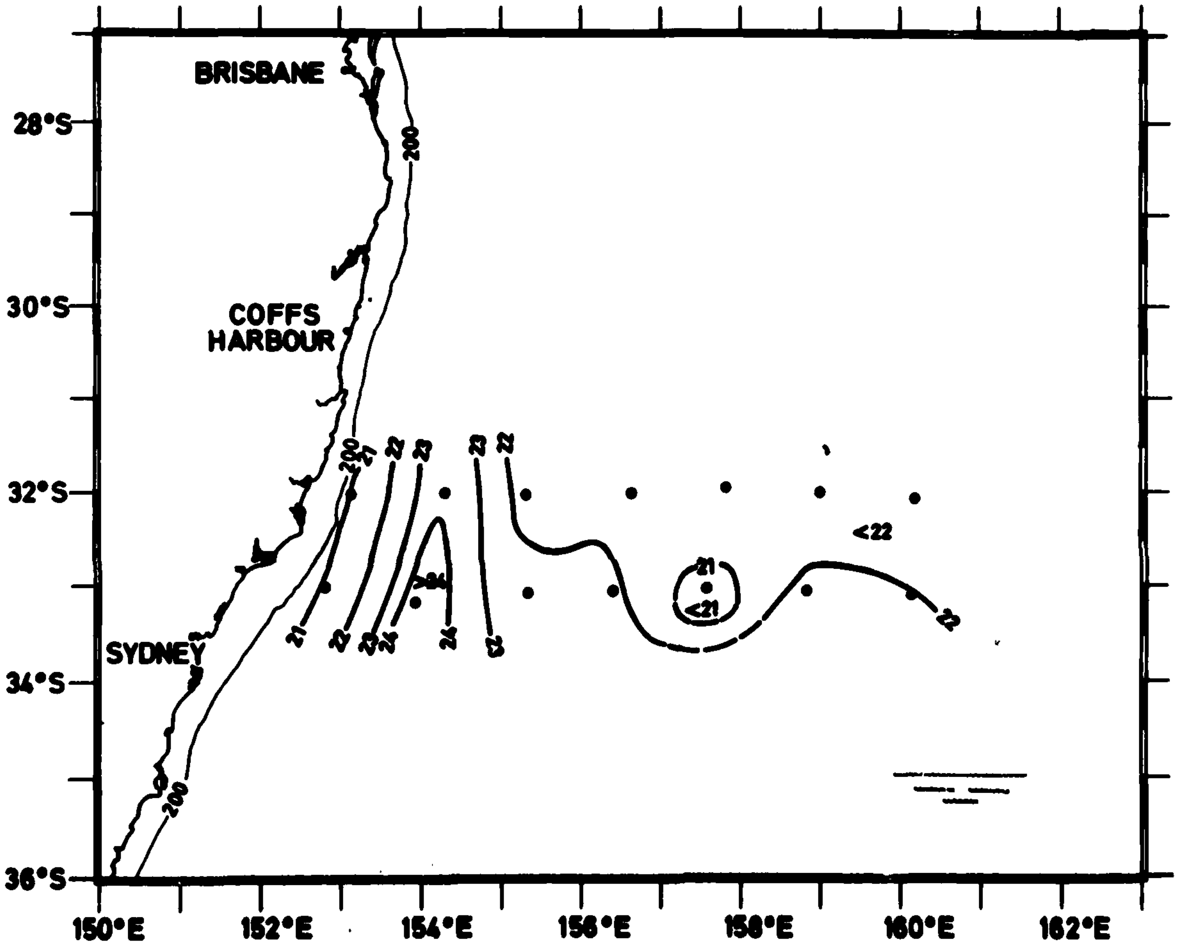

Figure 8 Surface Temperature (in degrees Celsius) 01 May 1979.

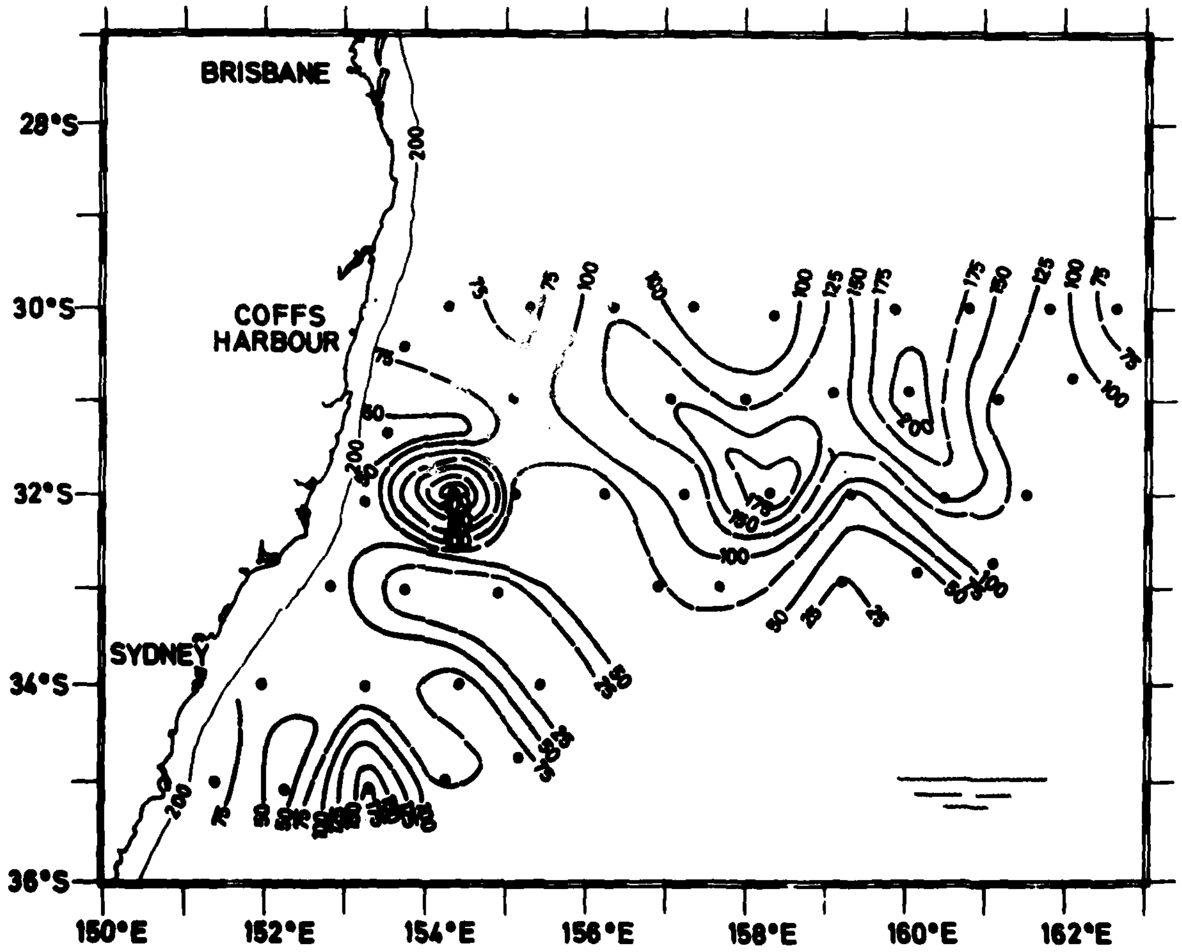

Figure 9 Mixed Layer Depth (in metres) 29-30 August 1978.

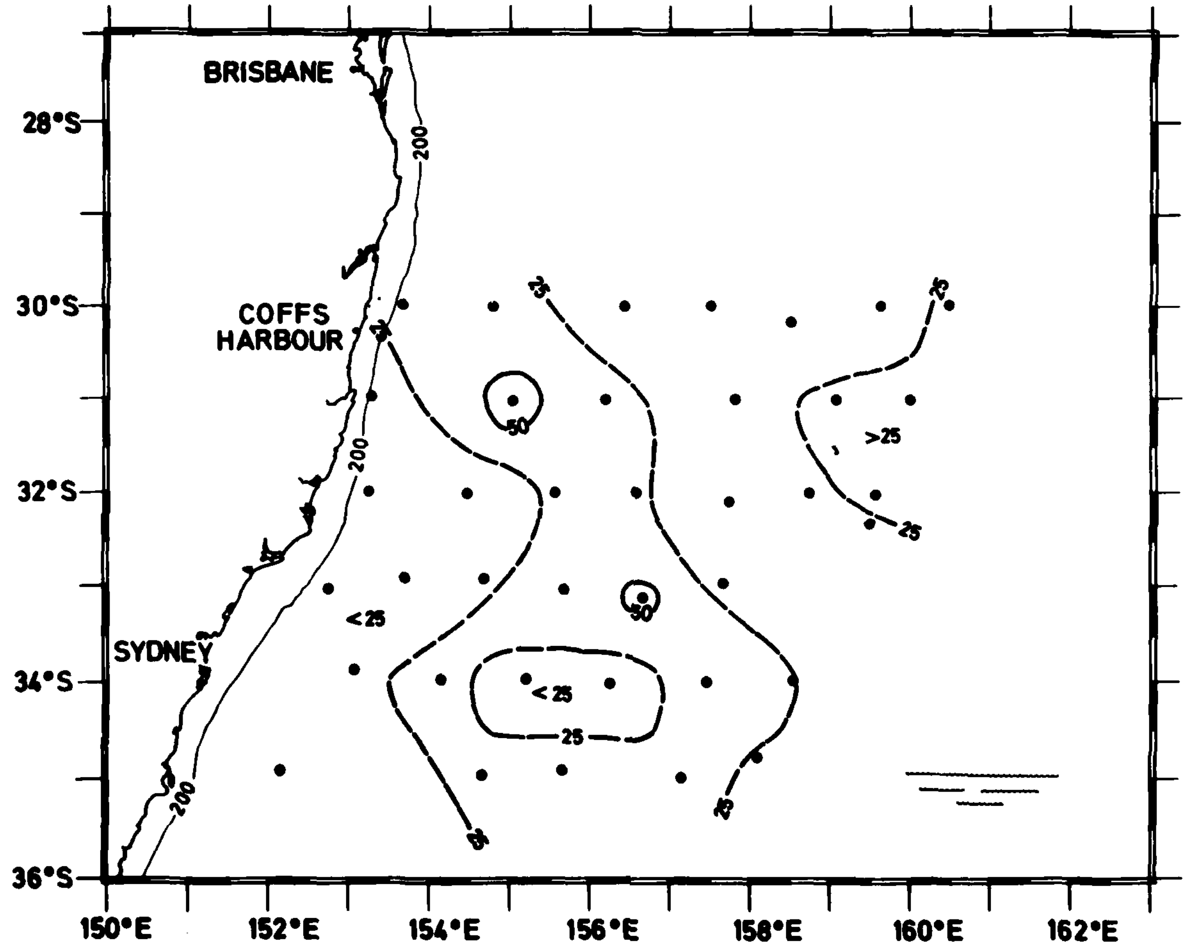

Figure 10 Mixed Layer Depth (in metres) 13 December 1978.

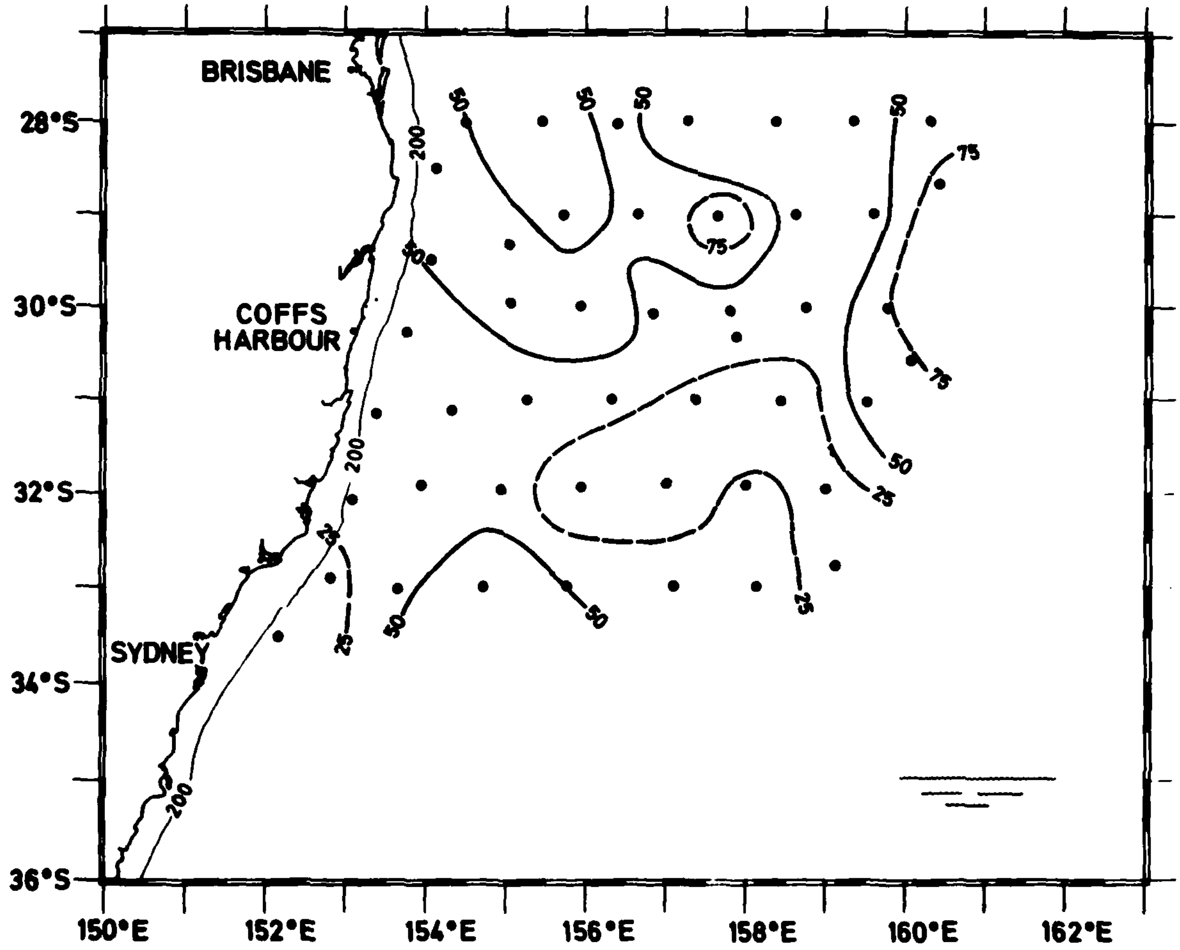

Figure 11 Mixed Layer Depth (in metres) 08 February 1979.

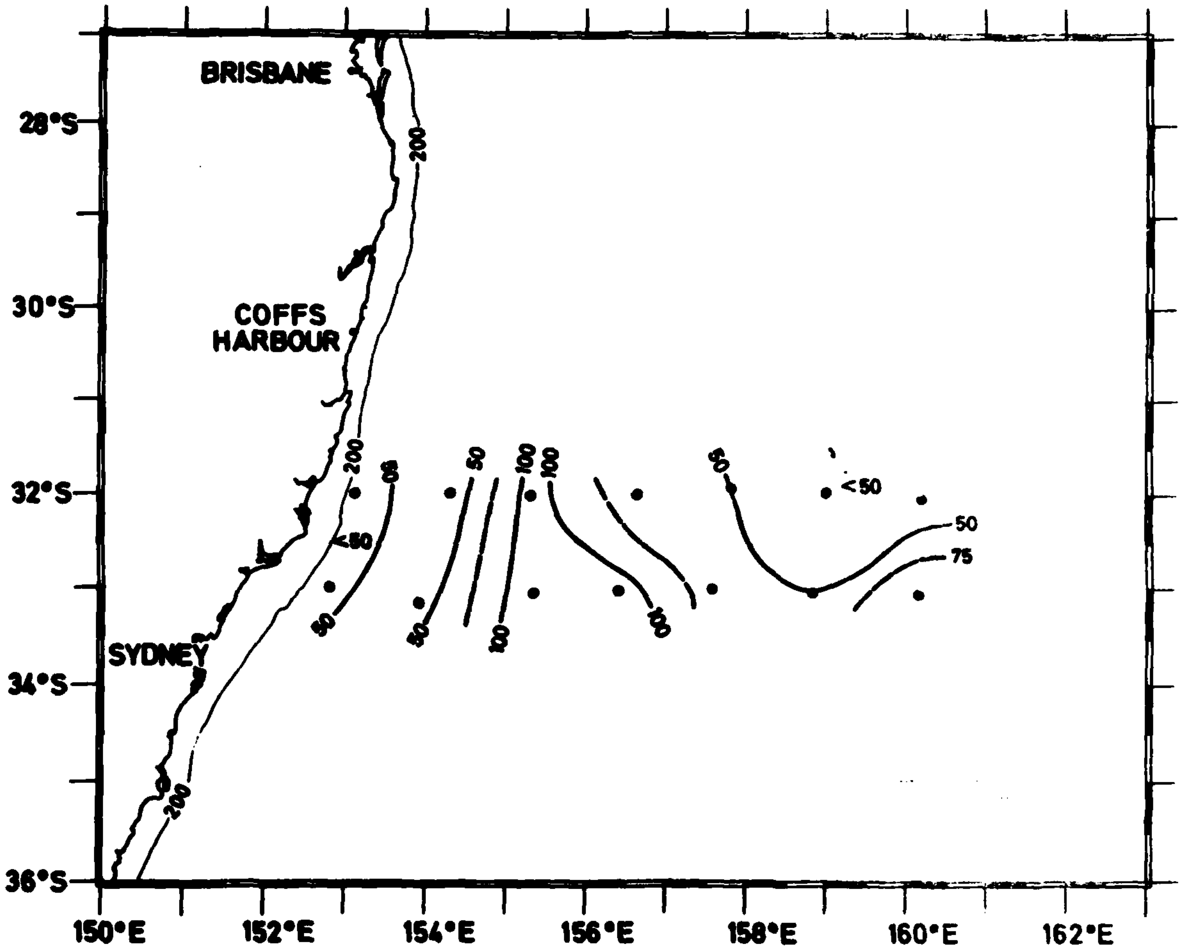

Figure 12 Mixed Layer Depth (in metres) 01 May 1979.

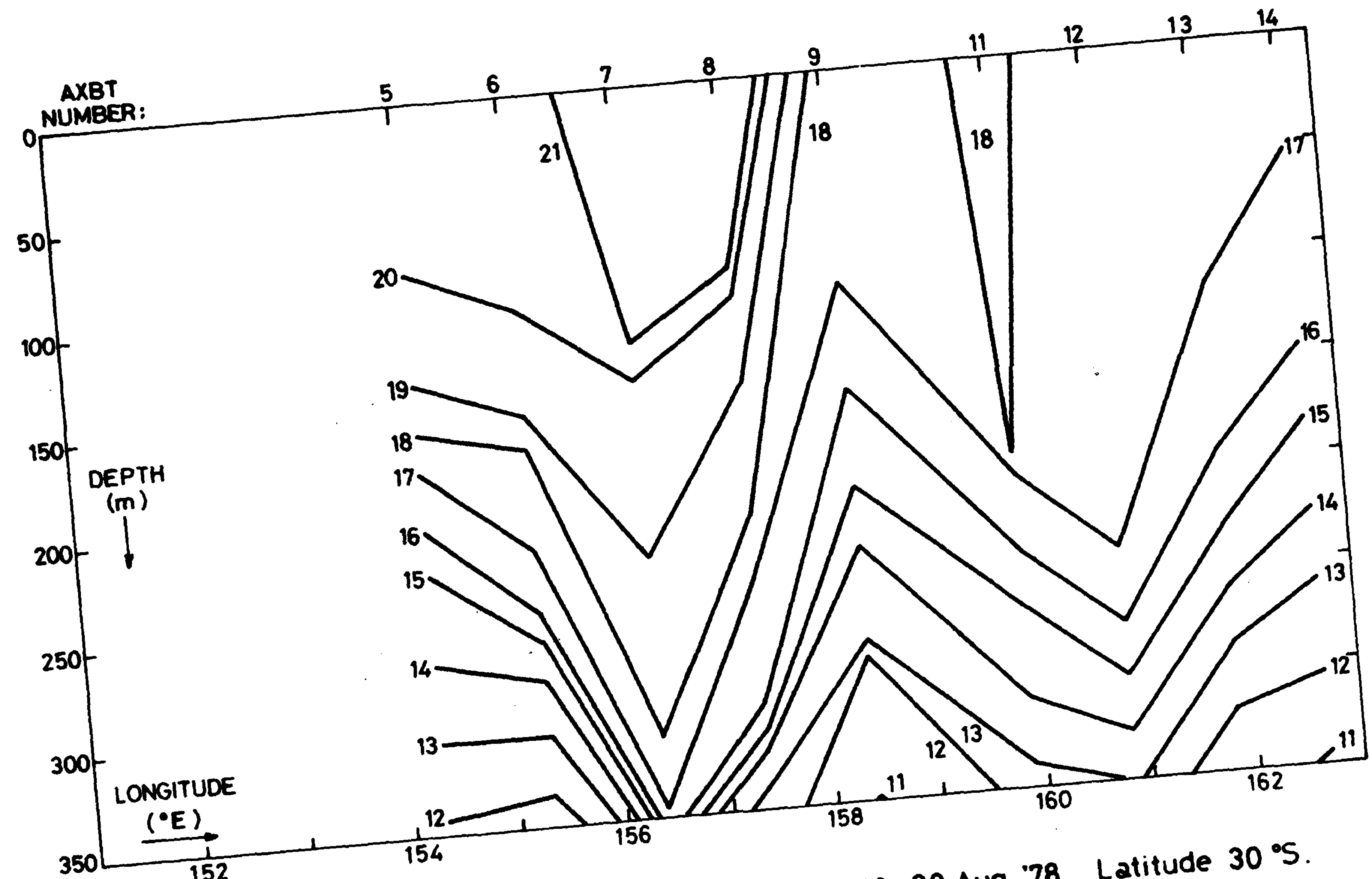

Fig.13 Vertical temperature section (°C). 29–30 Aug. '78 . Latitude 30 °S.

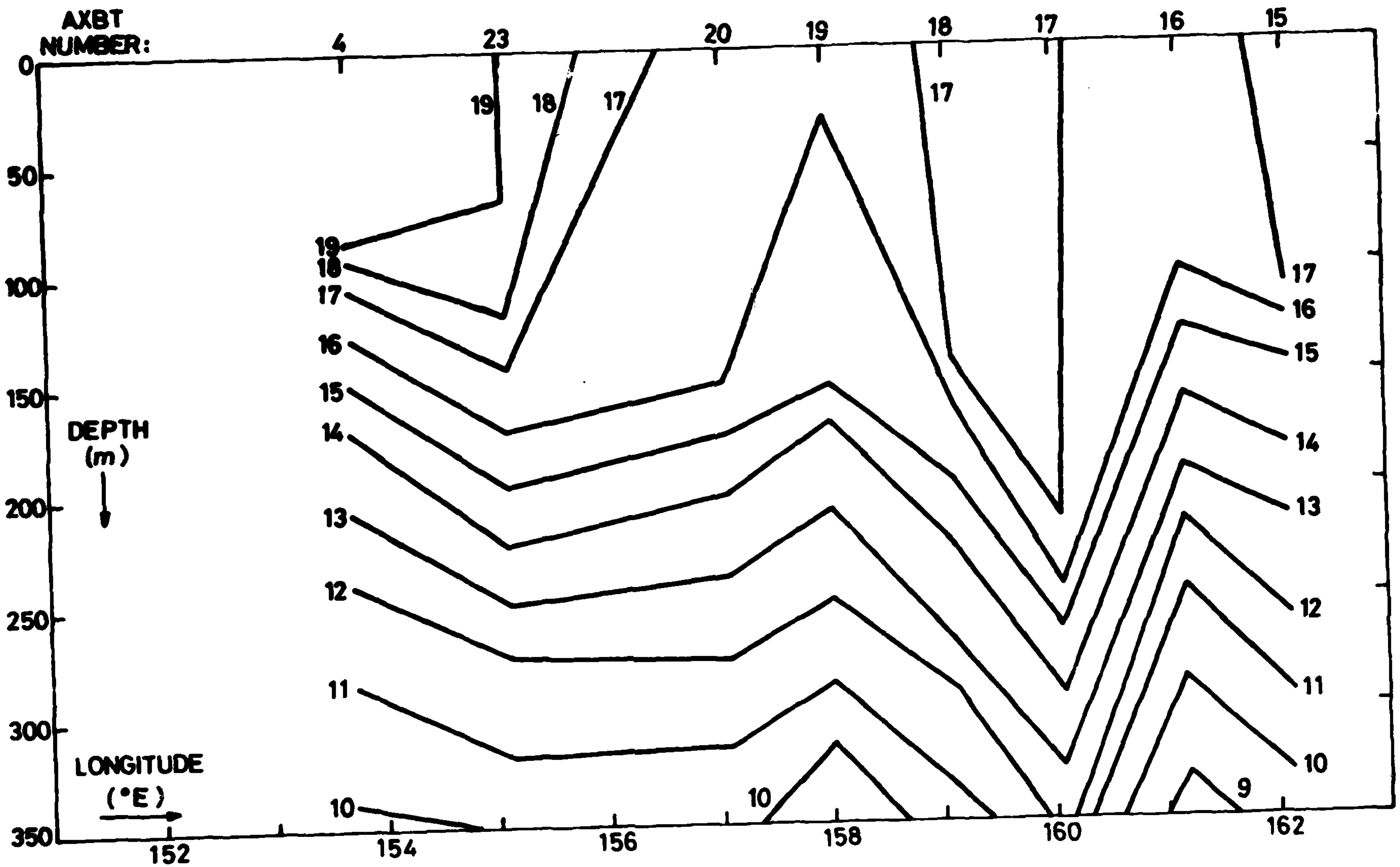

Fig.14 Vertical temperature section (°C). 29-30 Aug. '78. Latitude 31°S.

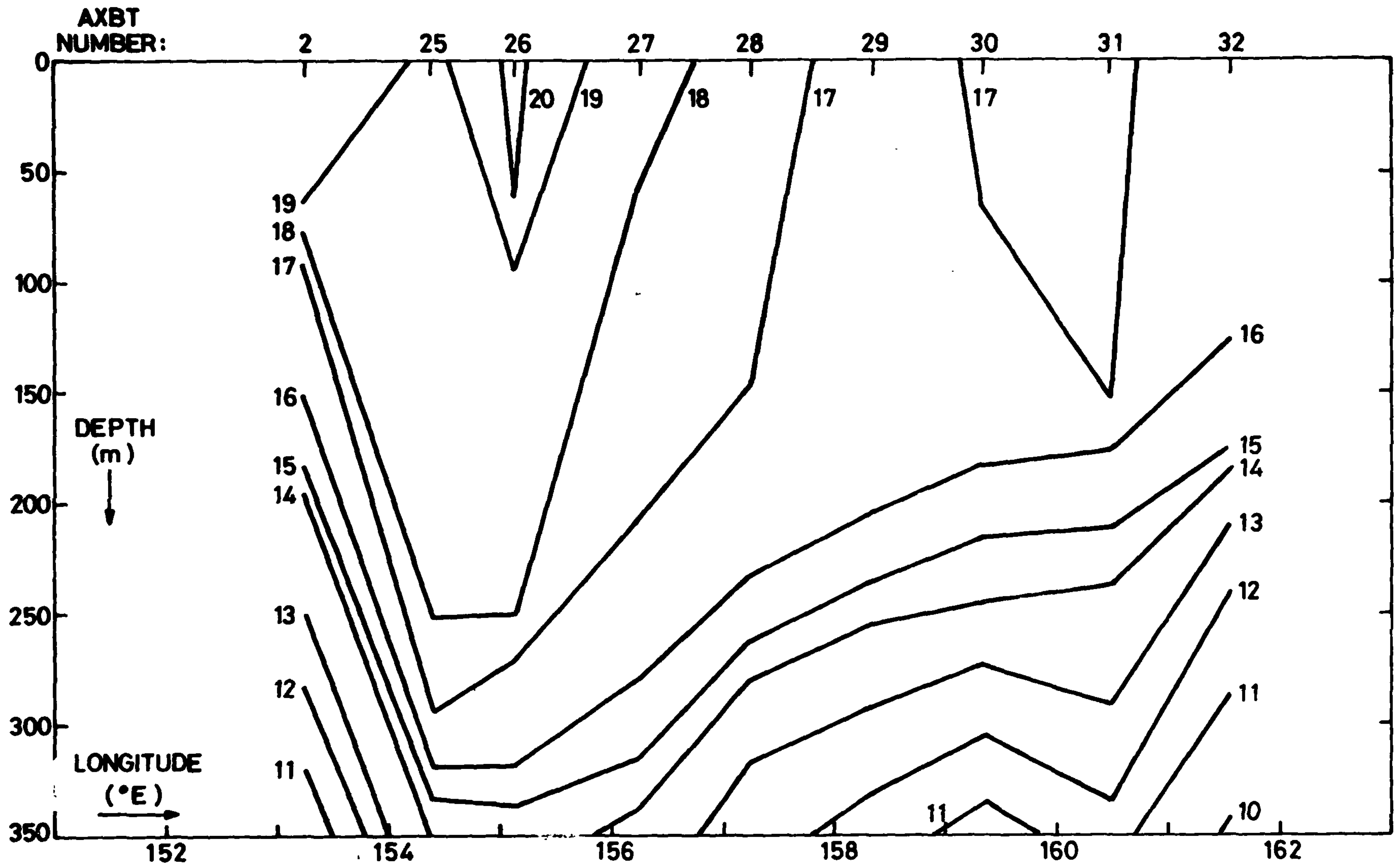

Fig. 15 Vertical temperature section (°C). 29-30 Aug '78. Latitude 32°S.

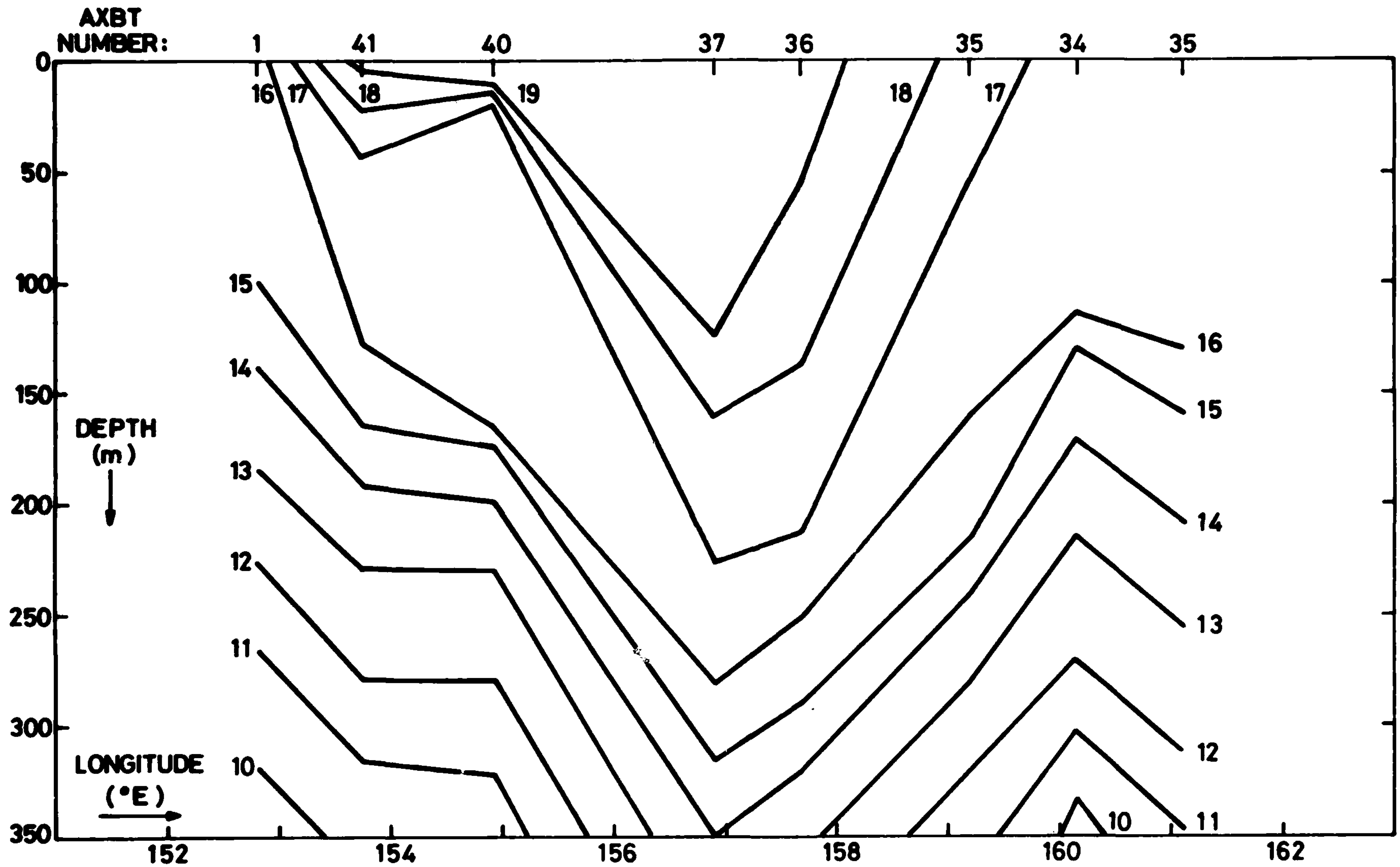

Fig. 16 Vertical temperature section (°C). 29-30 Aug. '78. Latitude 33°S.

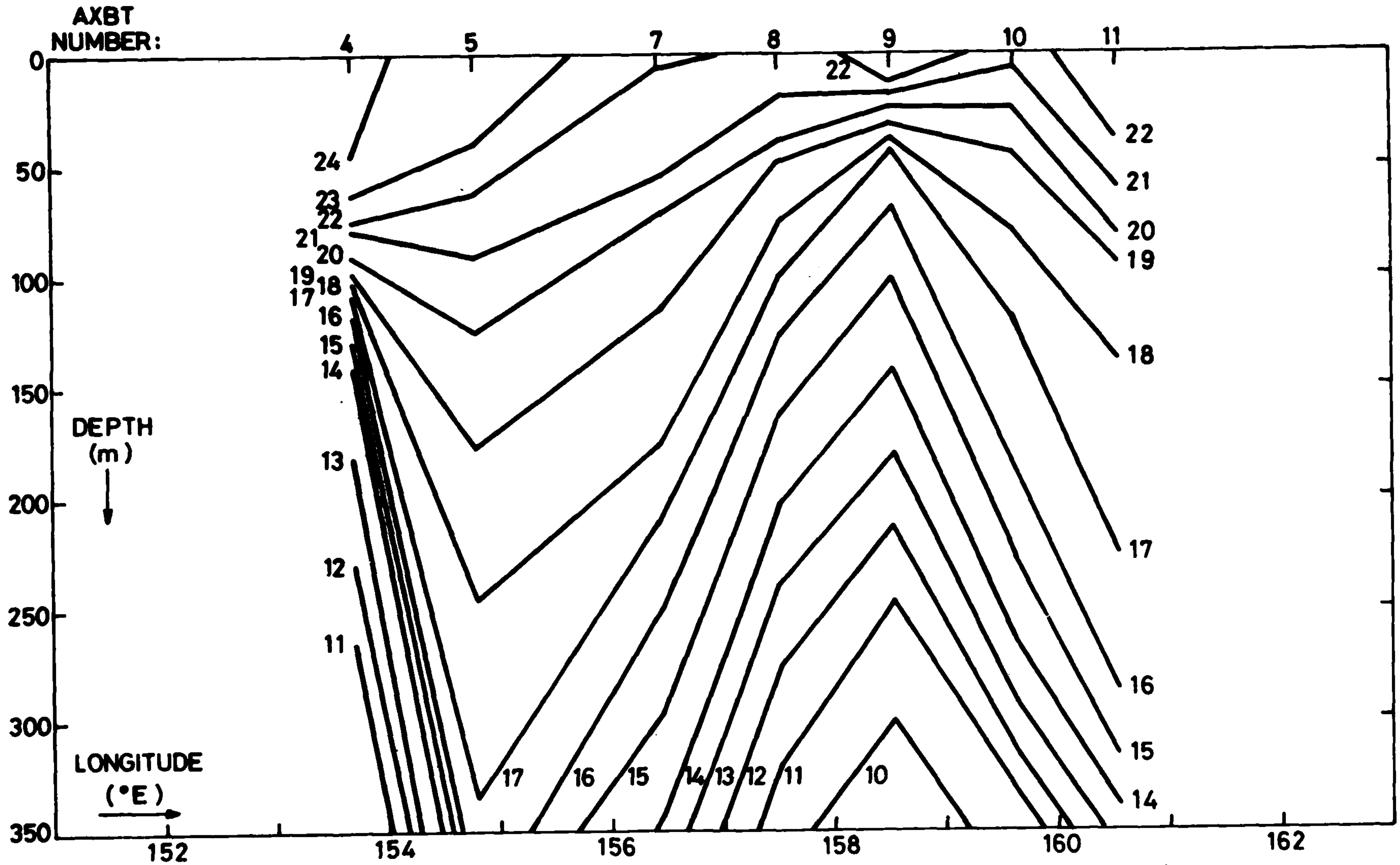

Fig. 17 Vertical temperature section (°C). 13 Dec. '78. Latitude 30°S.

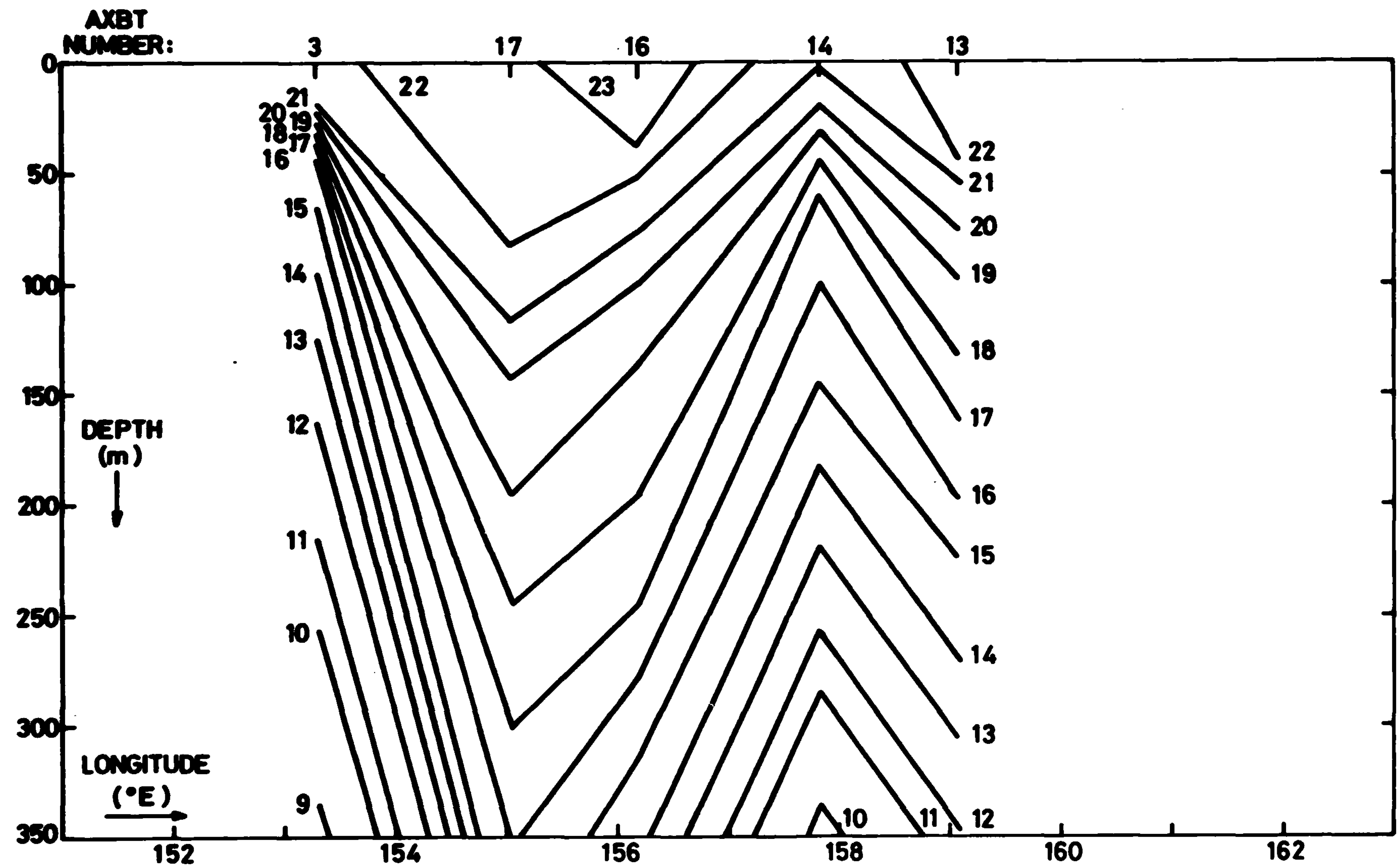

Fig. 18 Vertical temperature section (°C). 13 Dec. '78. Latitude 31°S.

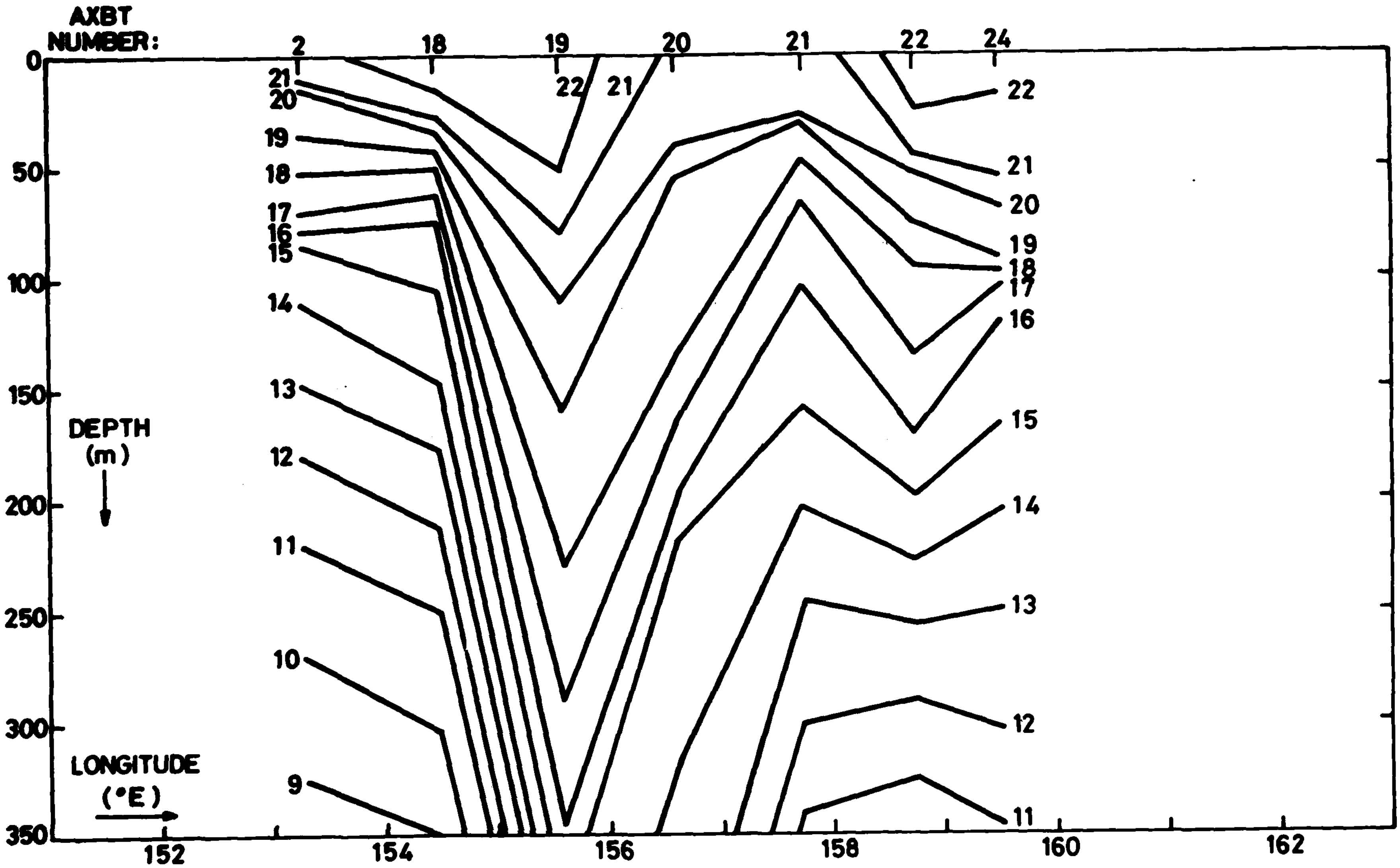

Fig. 19 Vertical temperature section (°C). 13 Dec. '78. Latitude 32 °S.

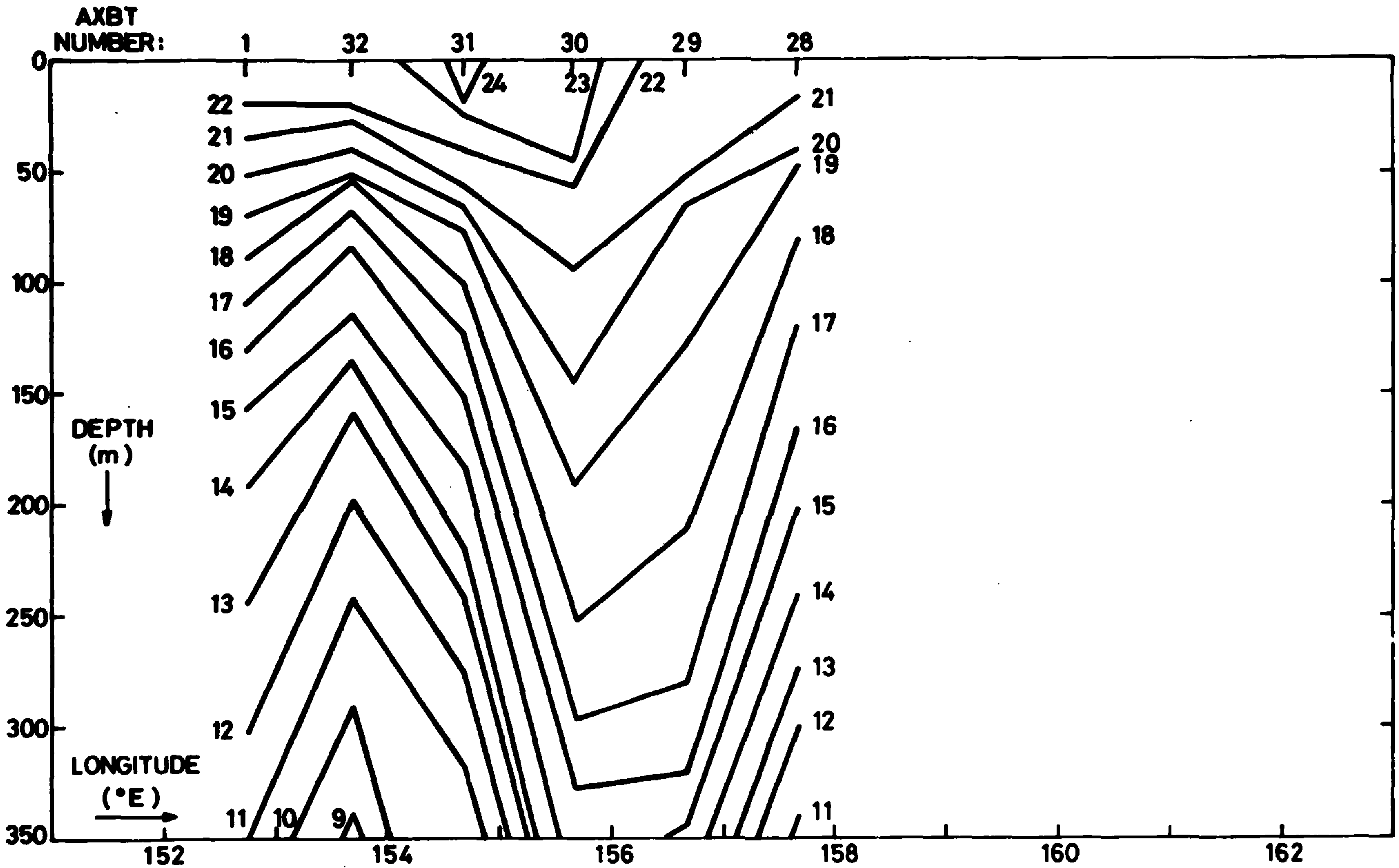

Fig. 20 Vertical temperature section (°C). 13 Dec. '78. . Latitude 33°S.

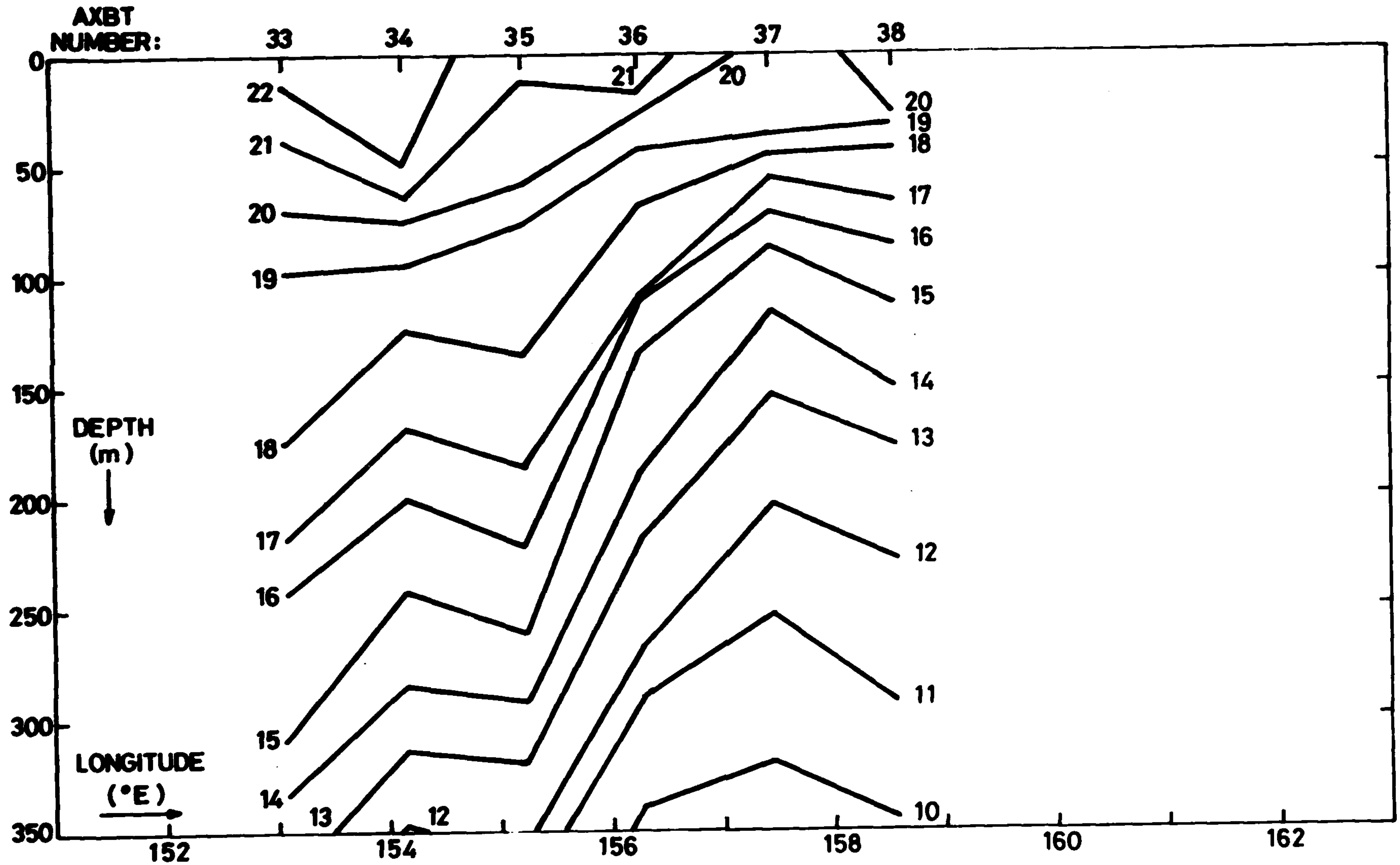

Fig. 21 Vertical temperature section (°C). 13 Dec. '78. Latitude 34°S.

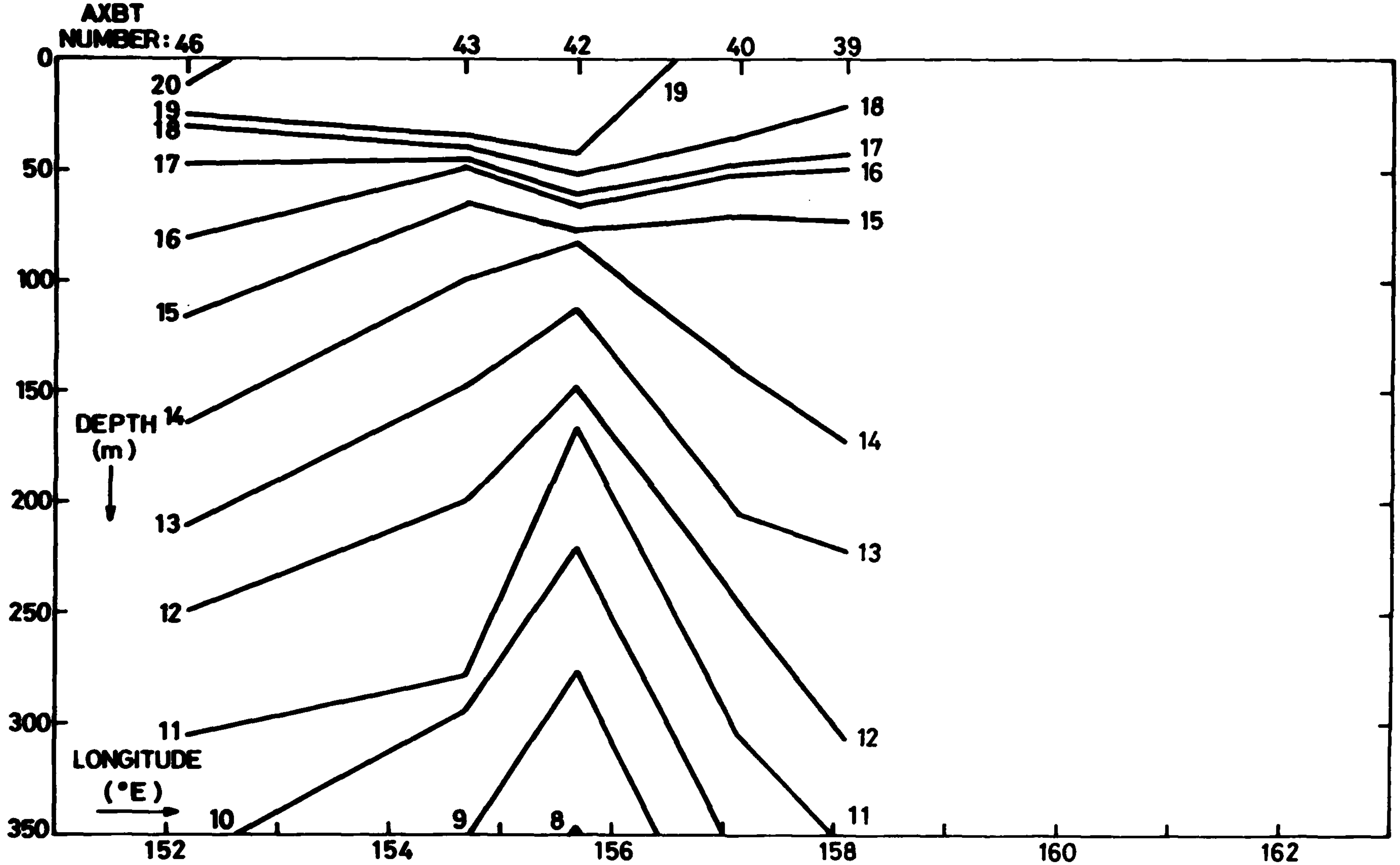

Fig. 22 Vertical temperature section (°C). 13 Dec. '78. Latitude 35°S.

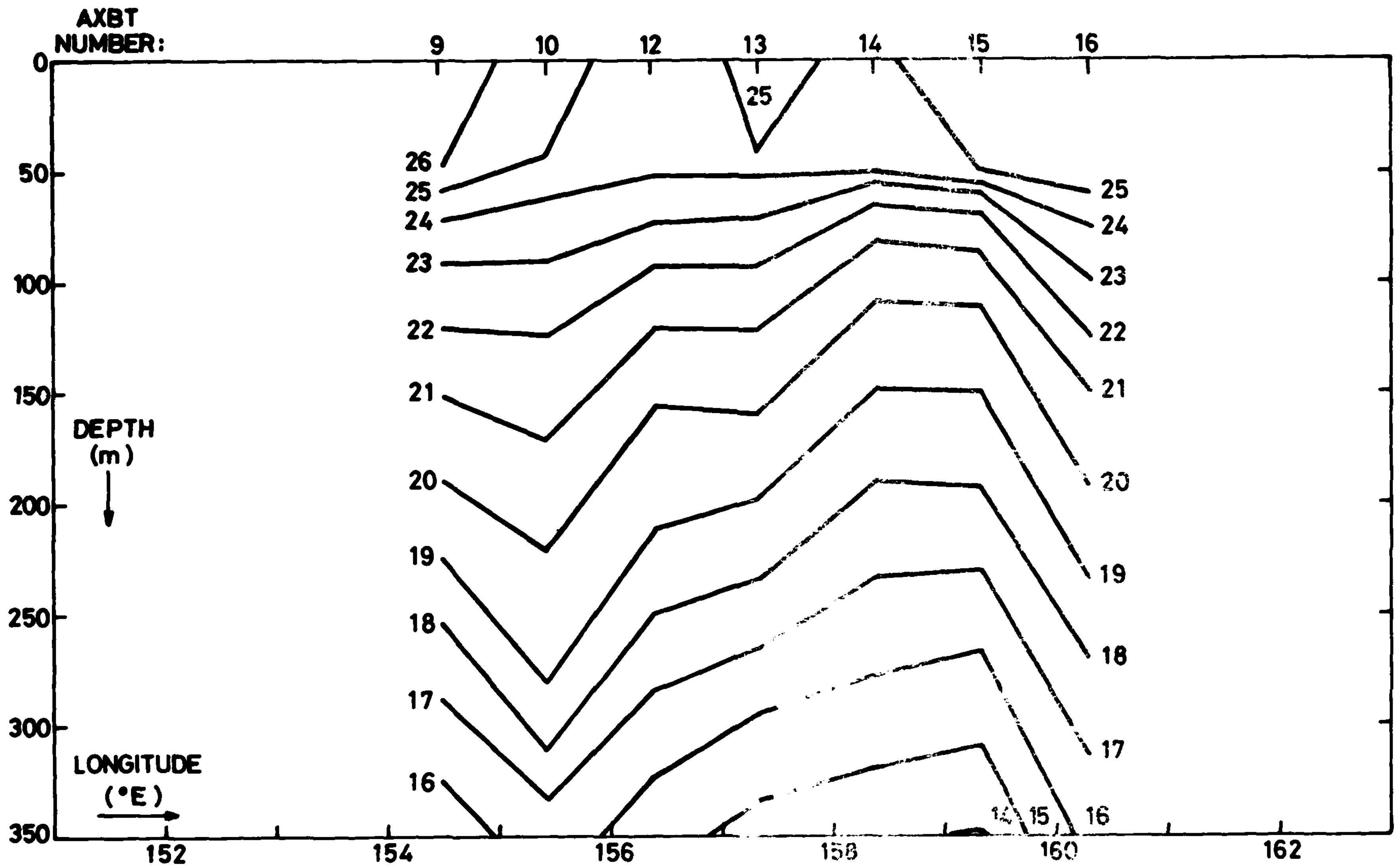

Fig. 23 Vertical temperature section (°C). 08 Feb. '79. Latitude 28°S.

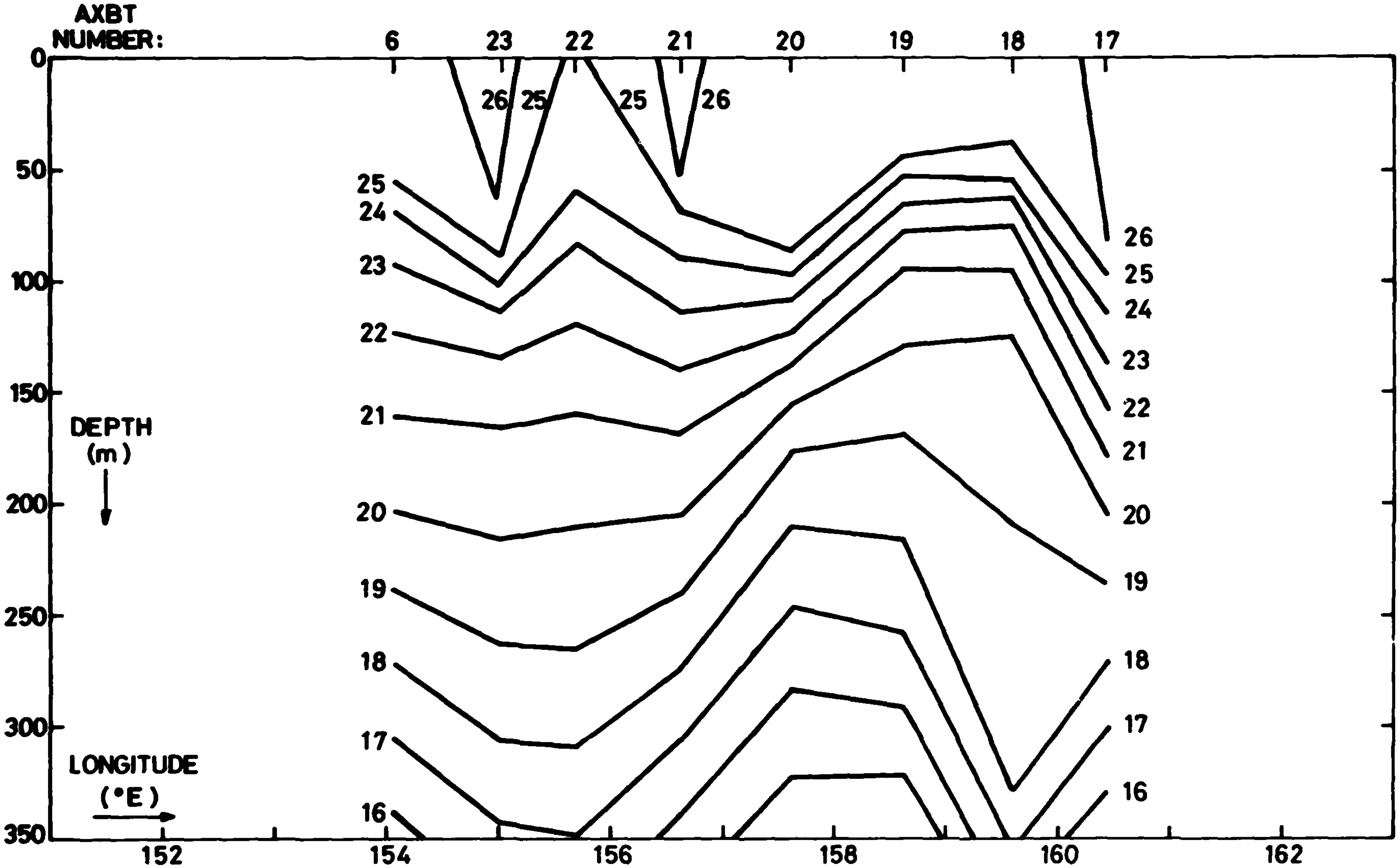

Fig. 24 Vertical temperature section (°C). 08 Feb. '79. Latitude 29 °S.

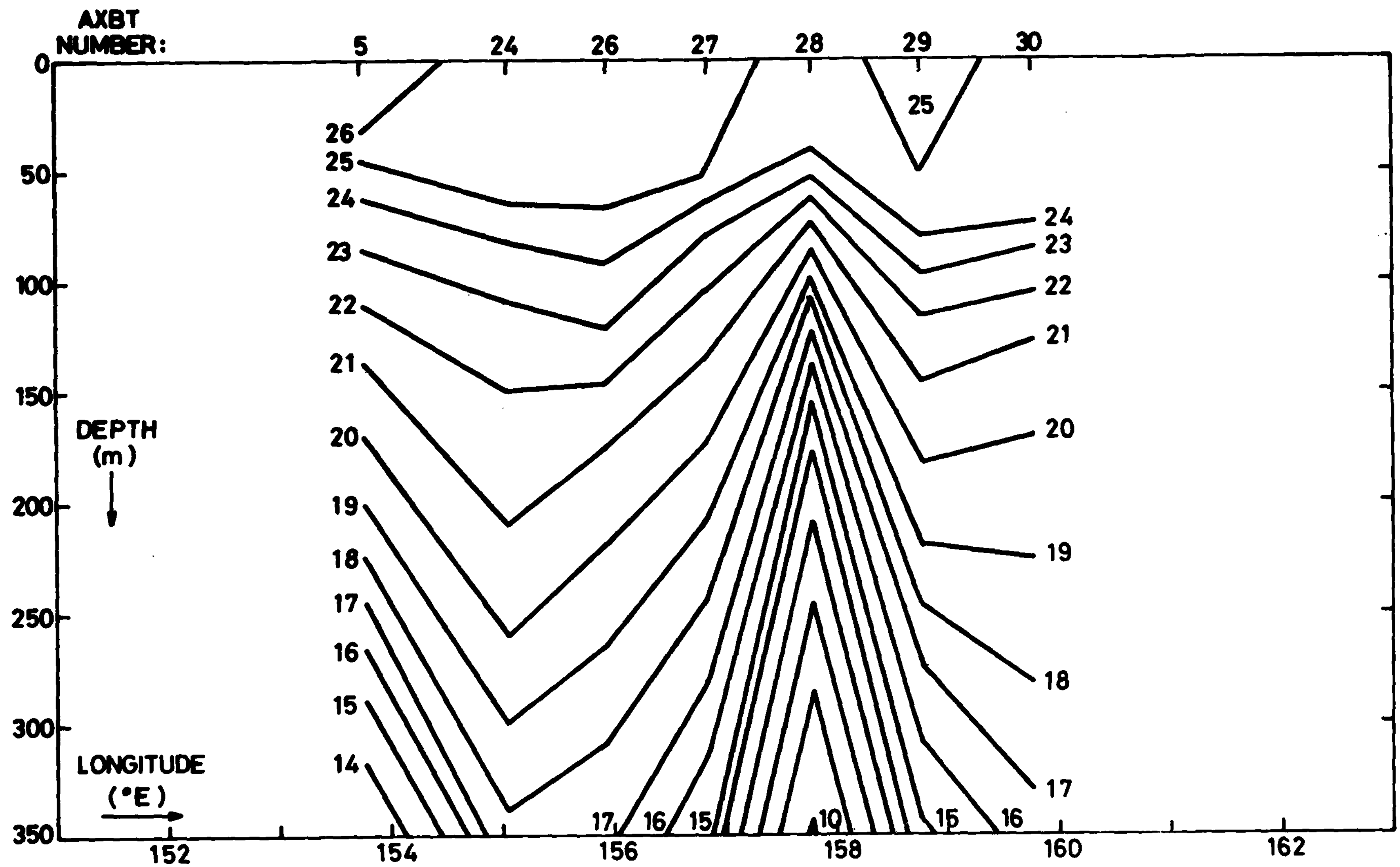

Fig. 25 Vertical temperature section (°C). 08 Feb. '79 Latitude 30 °S.

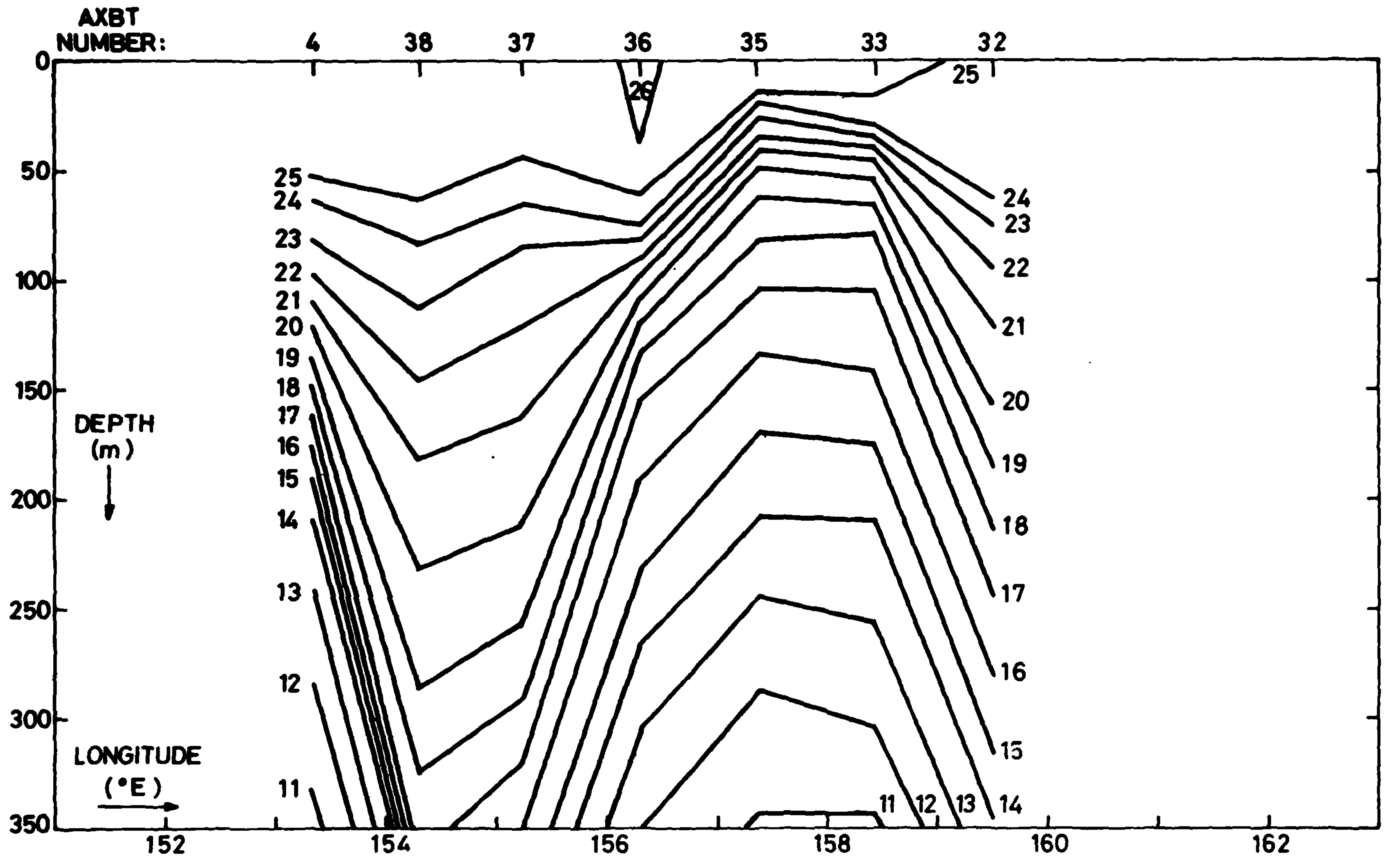

Fig. 26 Vertical temperature section (°C). 08 Feb. '79. Latitude 31°S.

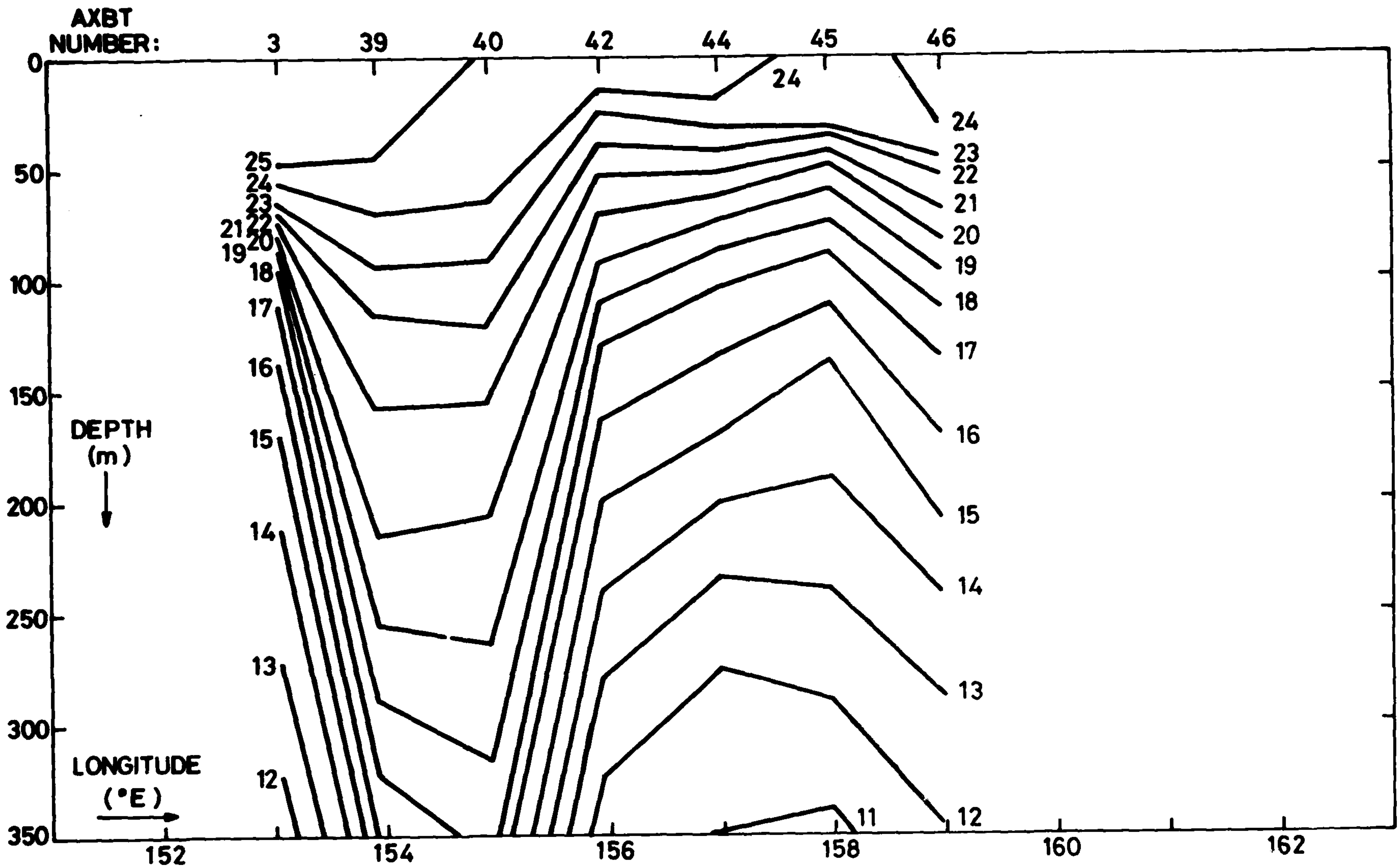

Fig. 27 Vertical temperature section (°C). 08 Feb. '79. Latitude 32 °S.

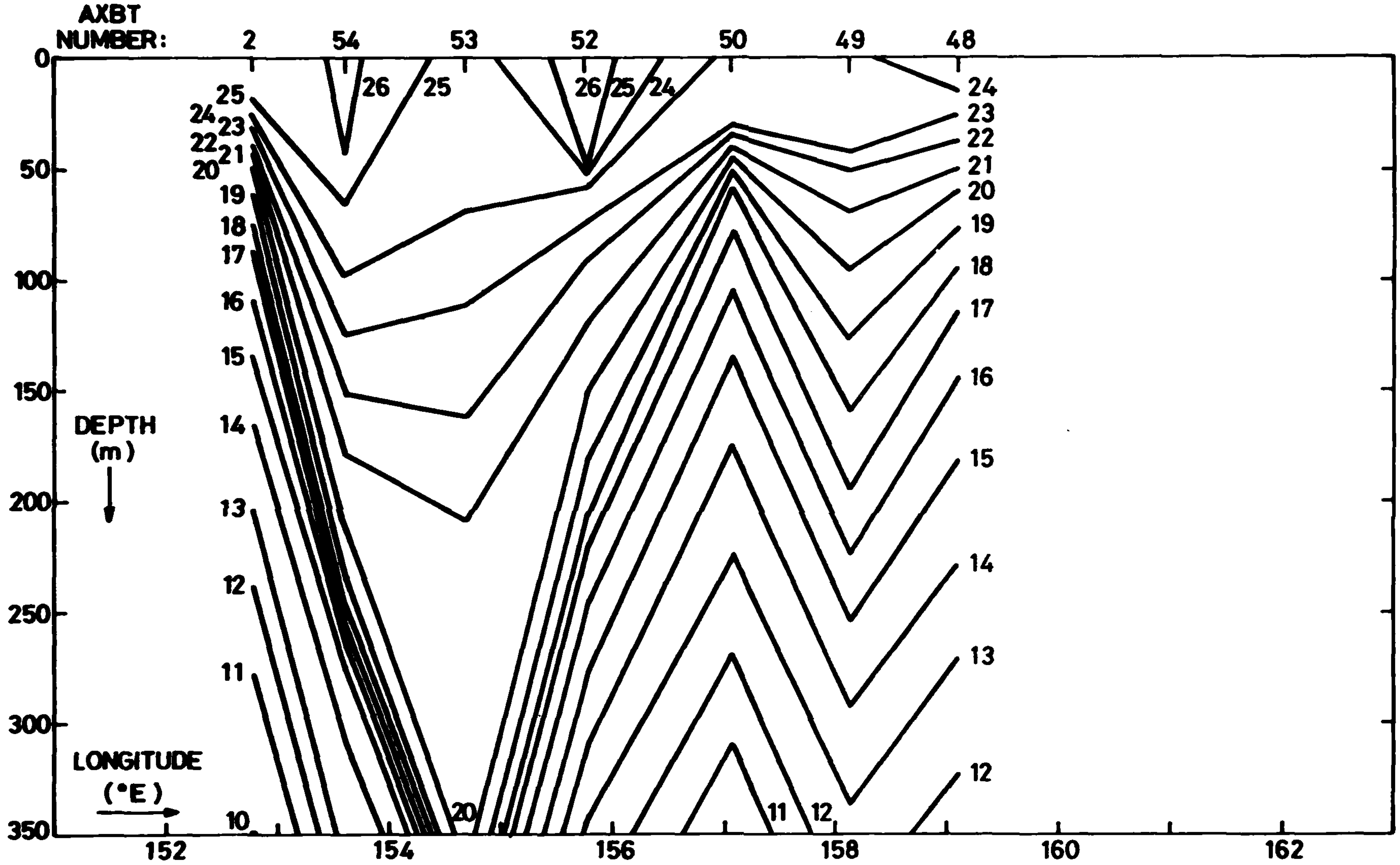

Fig. 28 Vertical temperature section (°C). 08 Feb. '79 Latitude 33°S.

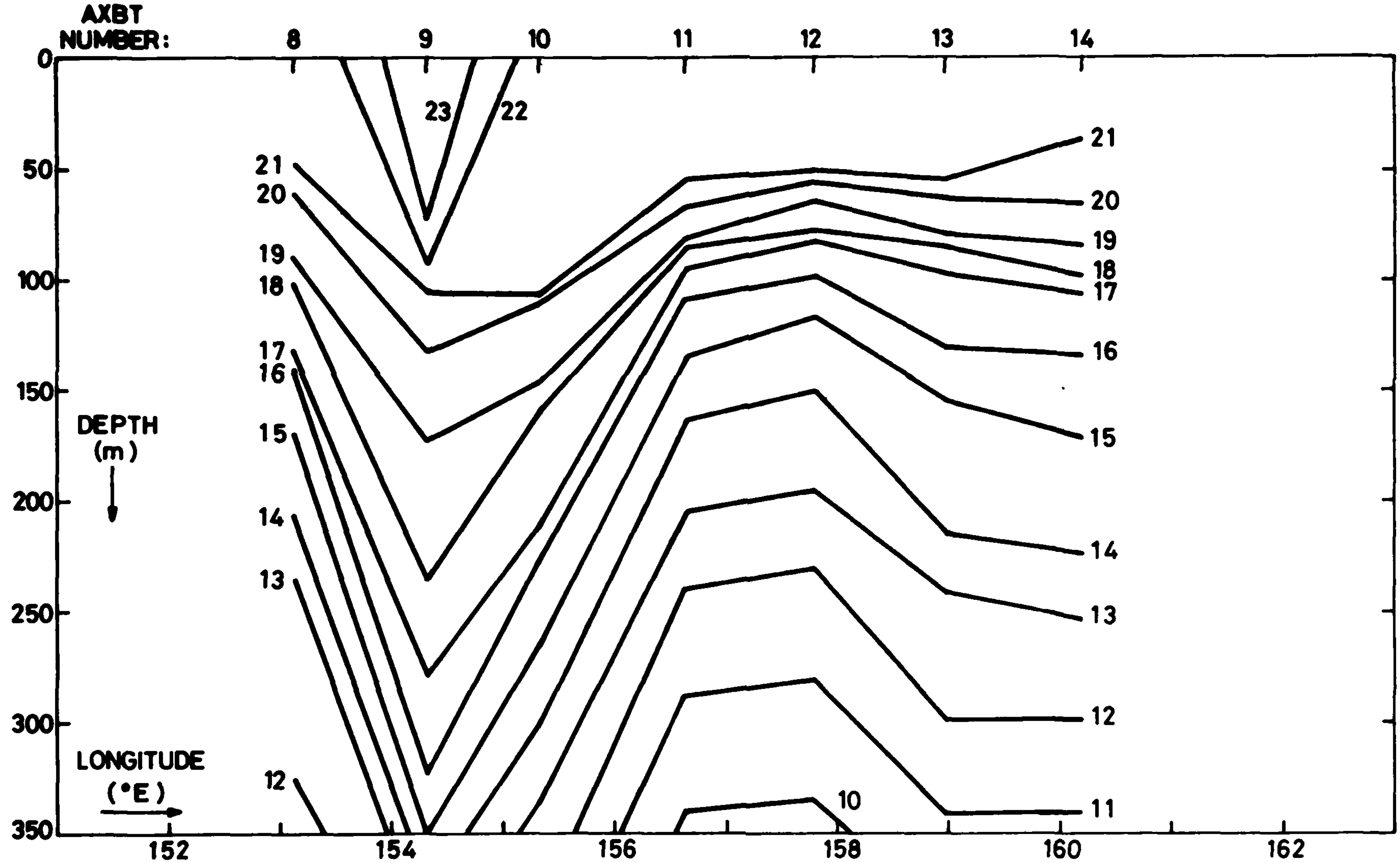

Fig. 29 Vertical temperature section (°C). 01 May '79. Latitude 32 °S.

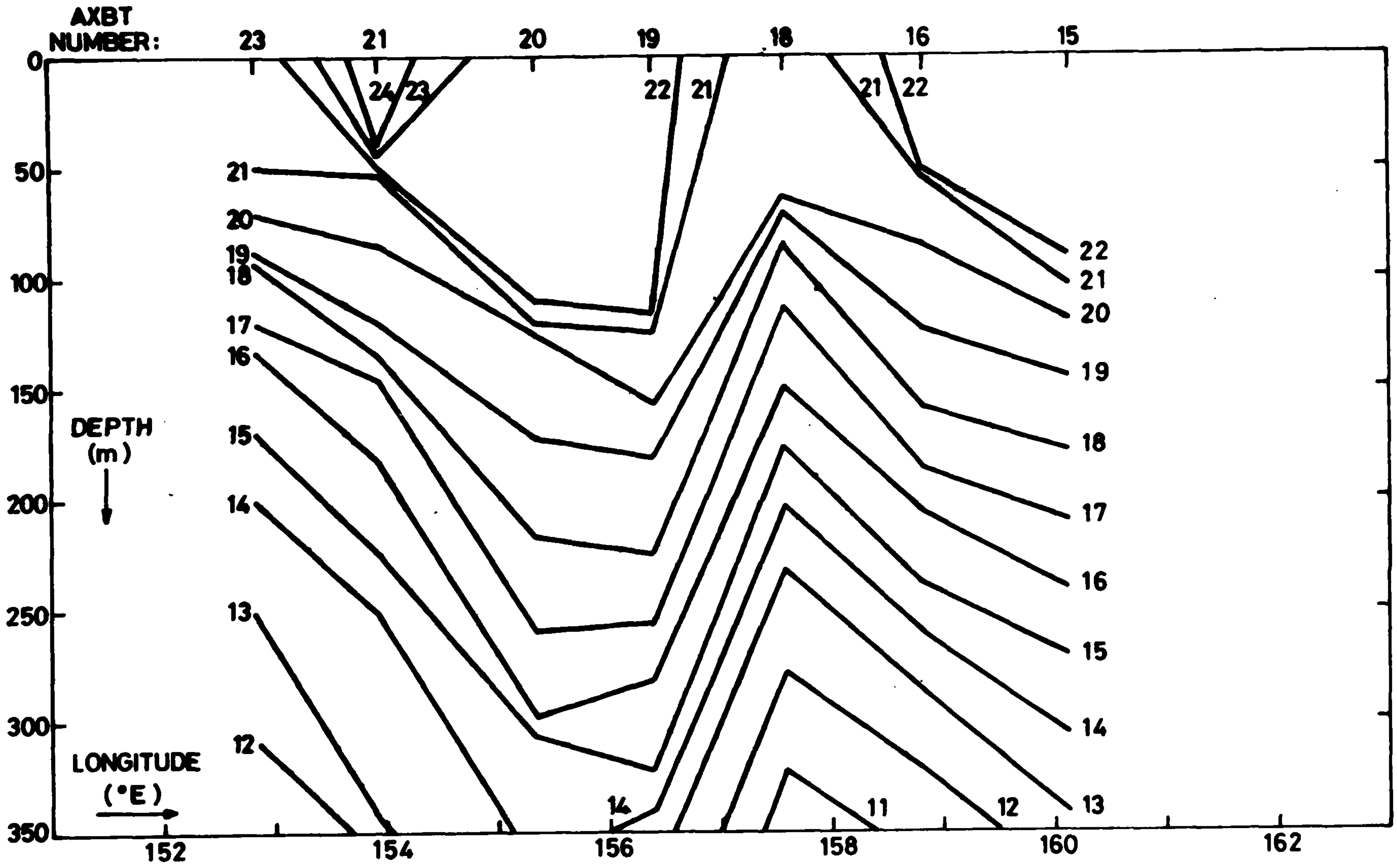

Fig. 30 Vertical temperature section (°C). 01 May '79. Latitude 33 °S.